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Developing Demand Planning in a Global Engineering Company

Master's Thesis

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Abstract

AALTO UNIVERSITY SCHOOL OF SCIENCE PO Box 11000, FI-00076 AALTO http://www.aalto.fi	ABSTRACT OF THE MASTER'S THESIS
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Title: Developing Demand Planning in a Global Engineering Company	
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This thesis examines the organization of an efficient demand planning process. Demand planning is examined as a part of the broader Sales and Operations Planning (S&OP) process. The goal of this thesis is to investigate what information is needed in the demand planning process, and how to organize the demand planning process to operate efficiently.

After a comprehensive literature review and interviews from five benchmark companies and the case company, the possible elements and the organization of a demand planning process are presented. Quantitative analysis is utilized in assessing the benefits of statistical forecasting and the market indicators. As a result it can be concluded that a statistical forecasting model modified by people with various information sources is often the basis for demand planning. The information sources can include market intelligence, customer information, project information and industry information from the product management.

The present situation of the case company is then analyzed through multiple interviews. These results are combined with the literature review and the analysis of the benchmark companies. Two solutions for the case company of how to organize its demand planning process are then formulated. One of these solutions is chosen for the case company to be implemented. An implementation plan is formed for both of these solutions. The solution that is suggested for the case company introduces statistical forecasting into the demand planning process and includes a recommendation to develop the process of how to gather and utilize the information from multiple sources.

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Tämä työ tutkii tehokkaan kysynnän ennustamisprosessin rakennetta. Kysynnän ennustamista tarkastellaan osana laajempaa Sales and Operations Planning (S&OP)-prosessia. Työn tavoitteena on selvittää, minkälainen informaatio on tarpeen kysynnän ennustamisprosessissa, ja miten kyseinen ennustamisprosessi organisoidaan tehokkaasti.

Kattavan kirjallisuuskatsauksen, viiden benchmark-yrityksen ja case-yrityksen haastattelujen jälkeen on luotu pohja kysynnän ennustamisprosessin mahdollisista osa-alueista ja prosessin organisoinnista. Kvantitatiivista analyysiä käytetään tutkittaessa mahdollisen tilastollisen analyysin ja markkinaindikaattorien hyötyjä. Tulokseksi saadaan, että kysynnän ennustamisprosessia tukee usein tilastollinen malli, jota ihmiset muuttavat monenlaisen informaation perusteella. Näitä informaation lähteitä voivat olla markkinaindikaattorit, asiakastieto, projekti-informaatio ja liiketoimintojen toimialatietämys.

Tämän selvityksen jälkeen case-yrityksen tämän hetkinen tilanne kartoitetaan haastattelujen kautta. Case-yrityksen analyysiosuutta peilataan kirjallisuuskatsaukseen ja vertailufirmojen analyysiin, jonka tuloksena luodaan kaksi kysynnän ennustamismallia, joista toista ehdotetaan case-firmalle implementoitavaksi. Molemmille vaihtoehdoille luodaan myös implementointisuunnitelma. Ehdotettava ratkaisu tuo case-yrityksen ennustamisprosessiin mukaan tilastollisen ennustamisen ja suosittaa informaation hyödyntämisen tehostamista.

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Enjoy reading!

30.1.2015 Espoo

Susanna Tulokas

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Abbreviations and notation

Abbreviation	Explanation
AEES	Adaptive Extended Exponential Smoothing
APP	Aggregate Production Planning
APS	Advanced Planning System
ARIMA	Autoregressive integrated moving average
ATO	Assemble-to-order
B2B	Business-to-business
BA	Business Area
BU	Business Unit
CPFR	Collaborative planning, forecasting and replenishment
CRM	Customer Relationship Management
CTO	Configure-to-order
DMO	Demand Management Organization
DSB	Demand Supply Balancing
DSOP	Demand Supply Operations Planning
ECR	Efficient Consumer Response
ERP	Enterprise Resource Planning
ETO	Engineer-to-order
IBP	Integrated Business Planning
KAM	Key Account Manager
KPI	Key Performance Indicator
MRP	Manufacturing Resource Planning
MTO	Make-to-order
MTS	Make-to-stock
OMTS	Open Model Time Series
PG	Product group
P&L	Profit and Loss
PMI	Purchase Managers' Index
S&OP	Sales & Operations Planning
SKU	Stock Keeping Unit
WMPE	Weighted Mean Percentage Error
VMI	Vendor Managed Inventory

1. Introduction

1.1. Background and motivation

Sales and Operations Planning (S&OP) has become a common process in organizations. It can be described as a process that facilitates balancing supply and demand, aligning plans on different levels and bringing strategy closer to the operations of the company. (Bower 2012; Alexander 2013) Operations have become more customer driven, moving away from the push mentality (Burrows III 2012). Thus companies have to be able to forecast the movements in the markets and use this information to plan their operations. The amount of information available is huge and the identification of relevant information can be challenging (Sagar 2011; Weigand et al. 2013).

Many companies struggle with challenges related to both S&OP and more specifically demand planning (Wallace & Stahl 2008). In a global and complex environment where many companies operate, a common challenge to demand planning is the selection of information sources. A large group of people is often involved in the planning process, which creates challenges for the information flow and the supporting processes and systems as well as for the value, correctness and relevance of the information. (Wallace & Stahl 2008; Wallace & Stahl 2006; Jurečka 2013)

FIGURE 1 S&OP PROCESS IN THE CASE COMPANY

One configuration of an S&OP process is demonstrated in Figure 1. Demand planning is the first step of S&OP, with a main purpose of developing an unconstrained demand plan. This unconstrained demand plan shows what the company could sell if the production side would not have any constraints on what can be produced and when. A common department responsible for the demand planning is often the Sales. (Wallace & Stahl 2008)

A large part of literature concerning S&OP is practitioners' work and it can be said that S&OP processes are often developed less in the academia and more in organizations. However, a one-size-fits-all solution for S&OP is quite impossible to develop. This is due to the fact that

the reasons for S&OP and the characteristics and backgrounds of companies and their operating environments differ from each other. In different organizations the emphasis of the process varies and the planning process is used to tackle different issues. Nevertheless, the process, when looking from the top level, is often quite similar.

Demand planning processes can prove out to be challenging. The processes and systems to store the required information can lack the needed features, which can make the demand planners' work challenging. Once the S&OP process has been implemented well in a company, planning systems can be the next issue restricting the improvement of the process. Demand planning processes often have to adapt to the restrictions of information systems. (Ivert & Jonsson 2010; Mentzer & Moon 2005)

This master's thesis identifies information sources needed in demand planning as well as maps a demand planning process that supports efficient planning. This means for example identifying what kind of a process supports the alignment of plans on different levels. The demand planning process and its relationship with management decision making will be reviewed both in the case company and the five benchmark companies.

1.2. Research questions and scope of the study

This master's thesis will be done as a case study of five benchmark companies and one case company. Information acquired from benchmark companies will be used to gain knowledge about how the S&OP process and more precisely the demand planning process studied in the literature review can be organized in various companies. The case company will go through more in depth analysis to acquire a comprehensive view of its S&OP and demand planning process.

The main research question of this thesis is formulated as:

> *How can demand planning be developed to function more efficiently and to provide more accurate and fact-based plans?*

This topic is developed further with two sub-questions:

> *What information is needed in the demand planning process?*
>
> *How should the demand planning process be organized to utilize the acquired information efficiently and to provide more accurate and fact-based plans?*

Demand planning and S&OP processes are often tied to strategic planning (Jurečka 2013; Alexander 2013; Bower 2012). The goal of S&OP is to have one set of plans that are relevant throughout the organization. Thus S&OP should contain the whole picture and connect plans from all the levels ranging from operations to strategy.

In this thesis the first topic to be covered in the literature review is strategic planning: its common characteristics and stakeholders. Demand planning process as part of strategic planning is then examined. This will help mapping the needs that should be filled by S&OP and demand planning. The process of creating the demand plan will then be examined, taking into account the different inputs for the demand plan.

To answer the first sub-question, the role of information coming from different sources is examined, including statistical forecasts based on history and judgmental adjustments based on e.g. market, customer, project and product management information. More investigation of the literature as well as the analysis of the benchmark companies and the case company will help answer the second sub-question: *How should the demand planning process be organized to utilize the acquired information efficiently and to provide more accurate and fact-based plans?*

Combining all of this information will help in answering the main research question: *How can demand planning be developed to function more efficiently and to provide more accurate and fact-based plans?* The same structure will be followed in the literature review, analysis of benchmark companies as well as the analysis of the case company.

The scope of the thesis within the case company includes two product groups (PG) of one of the case company's business units (BU). The goal is that the findings from these product groups can also be generalized to some extent to the other product groups of the case company. This thesis focuses only on the demand planning process and leaves out the operations' side. This will make it possible to take a deeper look into different aspects of demand planning, which is usually the most challenging part of S&OP. Forecasting methods are explored briefly, but specific regression models are not a part of the scope of this thesis. The examined management level is set to the global product group level in order to grasp the strategic aspect of the planning as well. Demand planning is looked at from the factory level point-of-view instead of the demand planning processes in the local sales offices. The views from local sales offices were taken into account when mapping how their information could be introduced in the factory demand planning process. The S&OP team in the factory has at the moment the responsibility and accountability of the results of S&OP, which is why this was found to be a good focus for the study. The focus of the study is in the mid and long term planning, which are more challenging for the case company, and the short term planning is out of the scope. The scope of the thesis is summarized in Table 1.

TABLE 1 SCOPE OF THE THESIS

	IN	OUT
Product groups	PG1, PG2	Other PGs of the business unit
Timeline	Mid and long term	Short term
S&OP	Demand planning	Operations/Master planning
Forecasting	Statistical forecasting, economic indicators	Specific regression models
Management level	Global product group management	
Demand planning	Factory level process	Local sales units' process

In the end of this thesis a suggestion for the organization of demand planning and an improvement plan for the case company will be developed.

1.3. Research methods

1.3.1. Research approach

The basis for the approach of this thesis lies in the process of building theory from case study research, introduced by Kathleen M. Eisenhardt in 1989. The theory building case study approach concentrates on understanding dynamics that are present in a single setting. To support this, various data collection methods are often combined. These methods may combine both qualitative and quantitative data. (K. M. Eisenhardt 1989)

Theory building case study research approach starts with having no predetermined theoretical perspectives or propositions in mind. The pre-existing theories or propositions might introduce bias to the research and limit the findings. Although theory is built from case studies, defining research questions at least in broad terms is important also in theory building case study research. This helps keeping focus and not being overwhelmed by the amount of data. However, it is important to remember that the research question and possible constructs identified in the beginning of the research are only tentative. The data found can lead the research into directions that could not have been foreseen earlier and might also lead to re-evaluating the research questions. (K. M. Eisenhardt 1989) In the scope of this thesis this approach means an iterative process of acquiring information from the case and benchmark companies and critically reviewing relevant literature that either supports or contradicts findings. Thus a framework that complies with the characteristics of the case company's environment can be identified.

When building theory from case studies, the case studies are often chosen based on theoretical sampling – choosing cases which are expected to either replicate or extend the emergent theory (K. M. Eisenhardt 1989). Theoretical sampling is used in this thesis, which means choosing benchmark companies with similar characteristics either in their business processes or operating environments. This enables the review of the topic from multiple perspectives, but still with benchmark cases that have characteristics similar to the case company – even while operating in different kinds of business environments.

1.3.2. Execution of the research and data collection

As explained in the previous section, the case study research approach starts without having clear theory or hypothesis in mind. This is also the case when starting this master's thesis. The master's thesis process starts by defining the research question to provide grounds for the research. However, in the process of this thesis, no hypotheses were developed based on the literature before starting the empirical research. The case study approach can be seen also in the iterative process of building evidence both from literature and the case studies. (K. M. Eisenhardt 1989)

This study is conducted by starting first with the literature review. Once basic knowledge about the topic is acquired, the data collection is started. This includes analysis of quantitative data and acquiring and analyzing qualitative data from the case company and benchmark companies. A total of 21 interviews were conducted between March and June 2014. Out of the interviews 16 were conducted within the case company and 5 in the benchmark companies. The interviews lasted between 45 and 90 minutes. Most of them were recorded on audio and rest of them in written form.

In the literature review three different topics are identified: S&OP, demand planning and strategic management. Literature concerning the latter two is mostly from academic sources, whereas literature about S&OP has quite a few sources in the practitioners' work. These topics form the basis of the semi-structured interviews with open questions that are conducted both in the case company and benchmark companies. The same structure is used in all interviews, though the focus of the interview differs depending on the position of the interviewee.

The qualitative empirical data was gathered mostly through interviews. In addition to that, quantitative data about order intakes was acquired from the case company. Market intelligence data was acquired through the market intelligence portal within the case company as well as from public websites. Information about statistical forecasting in the context of the case company is acquired from a study made inside the case company.

1.4. Structure of the thesis

This thesis consists of nine chapters. This introductory chapter will go through the motivation of the topic as well as introduce the research methods and the scope of the research.

A comprehensive literature review will form the second chapter. It will introduce the topics of management decision making and strategic planning, Sales and Operations Planning and demand planning. Demand planning will be reviewed in more detail. This will include identifying the characteristics of demand planning processes, the supporting systems and the information utilized to be able to plan more accurately.

Third chapter will introduce the benchmark companies and review their demand planning processes and their relationship with the management decision making. Based on chapters 2 and 3, chapter 4 will then provide a synthesis of findings from both literature and the benchmark companies.

Empirical analysis of the case company will be presented in the fifth chapter. The more thorough analysis will cover same topics that have been addressed in the literature review and benchmark company analysis. A summary of the findings from literature review, benchmark companies and the case company will be presented in the sixth chapter.

The seventh chapter will introduce the two possible solutions developed. This will answer the challenge of how the case company should develop its demand planning process to support management decision making better, thus answering the research questions. The eighth chapter will provide the recommendation for the case company based on the previous analysis.

The final, ninth, chapter will then conclude the thesis and provide evaluation of the study.

2. Literature review

2.1. Strategic planning

The need for corporate planning was already present in the 1970s and planning was found to be one of the most complex activities there is in organizations. Planning can be defined as a decision making process that is used to design the desired future and the ways of reaching it. (Ackoff 1970) **Strategic decision making and strategic planning** are often mentioned as some of the **most important tasks** of a company's board and management, but still it has been found that top management often lacks sufficient decision-making methods (Mintzberg et al. 1976). This was true in 1976 when Mintzberg et al. studied different decision making processes and although the decision making and planning tools have evolved, many top managers still lack visibility to necessary information to make fact-based decisions (Toor & Dhir 2011).

The general **strategic focus of the company** should affect its business planning process. Jurečka (2013) has developed different planning process set-ups based on the company's strategic focus, those adapted from Porter's classic work *Competitive Strategies.* The three directions that companies can focus on are *Cost Leadership, Focus on Customer Relations* and *Product/Service Differentiation.*

For a company which focuses on cost leadership, the leading functions in business planning are often Operations and Finance. The focus of the process is inventory minimization and the one number principle for supply, while the measured key performance indicators (KPIs) are often related to forecast accuracy, reduction of forecast bias and the inventory turns. (Jurečka 2013)

On the other hand, a company that focuses on customer relationships generally concentrates on sales planning, customer segmentation and risk and opportunities management. The leading functions in the business planning are Sales and Operations, and the measured KPIs often include customer retention, customer profitability and delivery reliability. (Jurečka 2013)

For companies focusing on product or service differentiation the focus of the business planning is often in scenario planning, product development and portfolio management. The leading function is often Marketing and the main KPIs include brand value and health, time-to-market, inventory obsolescence and the profitability of new products. (Jurečka 2013)

A more detailed description of the implications the strategy has on the planning process can be seen in Table 2.

TABLE 2 S&OP OWNERSHIP BASED ON KEY STRATEGIC FOCUS OF A COMPANY (JUREČKA 2013)

Generic strategy	Focus	Leading business function	Key Performance Indicators
Cost Leadership	• One number principle for supply • Volume • Costs • Inventory minimization	• Supply Chain/ Operations • Finance	• Forecast accuracy • Reduction of forecast bias • Inventory turns • Asset utilization
Focus on customer relations	• Sales planning • Impact of promotions • Customer segmentation • Risk and opportunities management • Revenue growth	• Sales • Supply Chain/ Operations	• Customer retention • Customer revenue/ profitability • Inventory turns • Delivery reliability
Product/ Service Differentiation	• Scenario planning • Product development • Portfolio management • Risk and opportunities management • Profit growth	• Marketing	• Profitability and revenue growth from new products • Brand value and health • Time-to-market • Inventory obsolescence

The key ingredient in having a successful planning process is to identify the business characteristics relevant to one's own business, then tailor the process to answer the needs of the organization and find the connection to strategy (Alexander 2013).

2.1.1. Strategic decision making

One of organizations' critical elements and managers' most important activities is decision making (Martinsons & Davison 2007). **Strategic decisions shape a firm's general direction** (Dean & Sharfman 1996), commit resources, direct important firm-level actions and are often characterized by novelty and complexity (Mintzberg et al. 1976). The processes underlying effective strategic decision-making lead to both organizational effectiveness (Dean & Sharfman 1996; Bourgeois & Eisenhardt 1988) and organizational efficiency (Kathleen M Eisenhardt 1989). The way managers make strategic choices has an impact on the outcome of the firm. These choices are influenced by the decision processes utilized in the firm and thus they are an important aspect of strategic planning. (Dean & Sharfman 1996)

Decision-making nowadays is characterized by access to information that is not restricted by organizational boundaries. Large data volumes are often involved in decision-making processes. (Shankaranarayanan & Cai 2006) This data should also be utilized, and **managers who collect information and use analytical techniques have been found to make decisions that are more effective**, compared to the decisions of managers who do not (Dean & Sharfman 1996). The decision making process is also impacted by the fact that strategic problems are often addressed by top managers working as a group (Schweiger et al. 1989). A group's decision making is dependent on the characteristics of the group, e.g. the cohesiveness of a group can reduce independent critical thinking. (Forbes & Milliken 1999)

Decision makers are frequently faced with situations where they have to understand, formulate and solve problems. This challenges the cognitive skills of managers and they have to face these situations with limited information-processing capabilities. (Yadav & Khazanchi 1992) Decisions are often characterized by multiple and conflicting criteria and strategies for near-optimal solutions are not relevant in these situations. Research has usually considered volatile alternatives and conflicting criteria separately and decision support systems are having difficulties in supporting situations when both of these two are present simultaneously. (Purao et al. 1999)

Different approaches to group strategic decision making have been researched quite a lot. For example collaborative decision making methods have been found to introduce group bias to collective assumptions. **Group thinking bias** in addition to other biases related to collaborative decision making methods often go unnoticed, as the people bringing the bias into the process do not recognize themselves as causing the bias. (Weigand et al. 2013)

Schweiger, Sandberg and Rechner (1989) compared the effectiveness of different approaches to group decision making. They found that approaches that contain **decisional conflict** often lead to **higher quality decisions** compered to consensus groups. This suggests that debate improves group performance by encouraging critical evaluation and formalizing and legitimizing conflict. Decisional conflict also has disadvantages and can result in lower group harmony (e.g. lower acceptance of the group decision and less desire to work together). Thus the **balance between decision quality and group harmony** has to be found. (Schweiger et al. 1989) These factors are relevant when forming planning processes as well, since the planning process is a clear case of group decision making. A continuous process including decision making should facilitate the decision making process by encouraging the critical thinking of people in the group, but at the same time maintain the group harmony of the S&OP group that is involved in the monthly process.

In addition to the group formation, the nature of the organization, the organizational context and the managers' prior knowledge and experiences also influence the strategic decision making process. For example the cognitive perception varies in different geographical areas, which leads to variation in cognitive biases in different geographical areas. (Mitchell et al. 2011) This has led to the questioning of globally applicable decision support systems, since decision making processes differ in different geographical areas (Martinsons & Davison 2007).

2.1.2. Sales and Operations Planning as part of strategic planning

As the strategic decision making has proved out to be a frequent topic in the organizational research, Sales and Operations Planning (S&OP) has evolved to answer the demand of bringing strategy to the everyday life of companies, and to facilitate the cross-organizational collaboration. The aggregate production planning (APP) from the 1950s developed into manufacturing resource planning (MRP II) in the mid-1980s and most studies on MRP II suggest that the origins of S&OP come from the practitioners' work in that area. Thus it can be said that S&OP has been developed quite a lot in the industry instead of academic research. There is a growing body of S&OP literature, but it's quite dispersed. From its origin of being just a way to balance demand and supply, S&OP has grown to gain the interest of senior management and to answer their strategic needs. Thomé et al. (2012) found that S&OP has a **two-fold main purpose** in both **balancing the supply and demand** and in **building bridges between the strategic and operational plans** of a company. Alignment of plans is one of the key themes in the field of strategic management and S&OP addresses this both

horizontally and vertically. (Thomé et al. 2012) This evolvement can be called Integrated Business Planning (IBP), Mature S&OP or Level IV S&OP, or it can be seen as a natural development of the original S&OP process.

Sales and Operations Planning (S&OP); Mature S&OP; Advanced S&OP; Integrated Business Planning (IBP); Sales, Inventory, and Operations Planning; Demand Supply Balancing (DSB); and Demand Supply Operations Planning (DSOP) are some of the terms used to call the company-wide management process that has evolved in the past decades to answer the need of a cross-functional collaborative planning within a company. The term S&OP will be used in this thesis to refer to the demand and supply balancing process that involves strategic reviews as well as strategic implications.

The traditional view of S&OP as merely balancing supply and demand is not enough nowadays. The focus has evolved to involve the reviews of strategy and portfolio changes, resulting financial implications as well as other strategic initiatives. (Jurečka 2013) **Executive participation** is a key element of successful S&OP to make it work as a strategic process that pays attention to the strategic alignment of tactical plans (Bower 2012). S&OP is often the key process used to be able to deploy strategy into the everyday business, thus providing a way to form a bridge in between the real-world delivery and the ideal world of the strategy (Alexander 2013). S&OP should also help in forming a consensus between a top-down strategy execution and bottom-up feedback from the market place (Jurečka 2013).

One of the key success factors of successful S&OP is the **commitment of the people** involved. This kind of commitment can be developed by enhancing the process to provide the relevant information for the stakeholders. This often includes:

- Focusing more on strategic concerns and the needed decisions
- Making sure that the structure of the S&OP process is aligned with the organizational structure
- Having a planning horizon that covers the timeline of strategic decisions (often at least two years)
- Making sure that the planning levels and the level of detail in the data support strategy-focused processes
- Expressing the plans in financial value to support the gap analysis, identification of opportunities and risks and financial planning
- Making sure that the chosen KPIs are not just left from the previous strategy but are kept aligned with the new strategic directions. (Alexander 2013)

The process of S&OP is often seen as a five-step process:

1) Sales will gather in informal or formal pre-meetings to share information about the future and develop an unconstraint demand plan. This plan should capture what a company can sell to its customers, not what it can produce. Anticipated responses to marketing plans and new product introductions should be taken into account.

2) In the second step the operations team has pre-meetings to gather information about the inventory strategy, supply chain capacity and internal capacity. Taking into account these constraints, the operations team will create an initial supply plan based on the unconstraint demand plan, resulting in a rough cut capacity plan.

3) After the first two steps have been completed, the S&OP team should formally meet to develop the final operating plan.

4) The fourth step is to distribute and implement the plan.

5) The fifth step is the measurement of results and the effectiveness of the S&OP process. This step is crucial in order to be able to continuously improve the process. (Grimson & Pyke 2007)

The S&OP process can also be examined by its main activities. Ivert & Jonsson (2010) suggest the five main activities in the S&OP process to be:

1) Forecasting the expected demand of the upcoming planning period, forecast made by the sales and marketing department.

2) Preparing the preliminary plan of future sales and delivery volumes (= demand plan). This plan is made by the sales and marketing department, and should take into account the goals for inventory size or order backlog.

3) Preparing a preliminary production plan (by the production departments and those responsible of procurement).

4) A reconciliation meeting involving the managers of the departments of marketing, production, procurement, financial and logistics departments. This meeting should provide a consensus production plan for the coming planning period.

5) Finally the consensus plan should be presented to the top management to gain the final approval and to resolve any remaining issues. (Ivert & Jonsson 2010)

Looking at the 5-step process made by Grimson & Pyke (2007), this thesis will cover steps 1, 4 and 5, while steps 2 and 3 are out of the scope, since they are not related to demand planning. When looking at the definitions of the main activities in S&OP made by Ivert & Jonsson (2010), activities 1, 2 and 5 are in the scope of this thesis, while activities 3 and 4 are not related to the development of the demand planning process and thus are not in the scope of this thesis.

2.1.3. Stakeholders of S&OP

There are usually **numerous people involved** in the S&OP process and the **teams are cross-functional**, having people from sales and marketing, operations and finance. When developing the unconstrained demand plan, involved groups of people may include people from for example Sales, Marketing and Product Management. To get an idea of the constraints to the plan, people from Operations join the process. In the final stages of reviewing the plan, people from Finance and the top management team are often included in the process. (Wallace & Stahl 2008; Wallace & Stahl 2006; Jurečka 2013) The effectiveness of an S&OP process is often increased by an "S&OP champion" – a senior executive participating in the meetings. Leadership is a critical aspect that needs to be present in the S&OP process to gain the full advantage of it. (Grimson & Pyke 2007)

The interests of different groups of people vary and can introduce complexity to the S&OP process. To answer all of these needs the process should be developed to conform to a variety of needs without losing the required simplicity. (Moon et al. 2000)

Inside companies there are often many "internal customer groups" that require accurate, credible forecasts. These customer groups or business processes can include for example finished goods inventory and production requirement planning, supplier coordination, strategic planning gap analysis and commitment to external customers and internal sales teams. In their study Moon et al. (2000) found that the customer demand planning organization can be seen as an interfunctional process which oversees the collection of data from different organizational functions and then provides the information that facilitates effective decision making in other organizational functions, such as finance and manufacturing. (Moon et al. 2000)

2.2. Demand planning as part of strategic planning

The market place is changing and the business of buying is moving from the supply-driven models towards market-driven and customer-centric ones. Customers are now in charge and they get to dictate what kind of products they want and when. This sometimes leads to specialization of products to satisfy the customers' needs. While S&OP was traditionally more of a process for operations, in today's on-demand economy the demand is dominating supply as the driving force. One could say that the **supply chain is just as good as the forecasts.** (Burrows III 2012) This has led to the fact that demand management/demand chain management has emerged as a new topic of study when previously distribution has been viewed as the key link between a company's customers and its internal supply chain activities (Rexhausen et al. 2012).

Constant discontinuities and changes in the market conditions requiring fast actions are **making demand planning and shaping a critical process to be able to cope with the changes in the operating environment** (Makatsoris & Chang 2004). Especially for supply-chain companies demand forecasting is a crucial aspect of the planning process (Fildes et al. 2009). The demand chain management focuses more on the marketing, sales and services' part of the value proposition and tries to obtain a more reliable and detailed view about (prospective) customers (Van Landeghem & Vanmaele 2002).

The integration of both demand chain management and supply chain management is key to the development of supply chains that deliver the right products and services (Van Landeghem & Vanmaele 2002). To benefit from supply chain management, the demand chain management needs to be a priority as well. (Mentzer & Moon 2004) Although the popularity of demand planning as a research topic has grown, **in depth analysis on its impacts on supply chain performance are still missing** (Rexhausen et al. 2012). Research addressing the demand creation and demand fulfillment processes and their coordination on organizational and supply chain level is still limited (Hilletofth et al. 2009). The sales forecasting management has also been neglected in the research field and even though the technical side of sales forecasting has gotten quite a lot of attention, the managing of forecasting activities has not (Winklhofer et al. 1996). External supply chain collaboration operates with the main objective of reducing uncertainty via the transparency of information flows (Holweg et al. 2005).

When doing demand planning, a clear distinction between forecasts, plans and goals should be made. This is not always done and these terms can be utilized synonymously in an

organization, guiding behaviors in the wrong direction and often also adding inefficiencies and cost. A sales forecast assumes the given environmental conditions and is a projection into the future of the expected demand. Sales forecasts can be developed with any given technique (quantitative or qualitative). In using sales forecasting, a company tries to understand the future customer demand, in order to develop a plan with which the sales of that level can be achieved. Plans are a set of managerial actions to meet or exceed the sales forecast. Forecasts and plans are different from sales targets, which are goals that have been established to provide motivation for Sales and Marketing personnel. (Mentzer & Moon 2004)

When involved in a demand planning process, it is important to know the difference between different types of demand. Mentzer and Moon (2005) identified three different types of demand that might require different forecasting processes:

- Independent demand is the amount of product demanded by the end-use customer of the supply chain. The company in a supply chain that directly serves the customer experiences the independent demand.

- Derived demand is the demand derived from what other companies do to meet their demand from their immediate customers.

- Dependent demand is the demand for the components that go into a product. The dependent demand of components is usually dependent on the demand of the final product.

The **systems, processes and techniques required to handle demand** depend largely on the type of demand. The failure to recognize the difference between these can lead to increased safety stocks in various parts of the supply chain. It is important to notice that while independent demand needs to be forecasted, derived and dependent demand can also be derived and planned. (Mentzer & Moon 2005)

Demand planning can be defined as *the coordinated flow of derived and dependent demand through companies in the supply chain.* (Mentzer & Moon 2005) [p.3] The difference to traditional supply chains is the fact that other companies in a supply chain do not try to forecast the demand of their customers but instead receive the point-of-sales demand information from the retailer. This usually decreases the inventories to all members in the supply chain, but more to the ones further in the supply chain, whereas the more critical firms to implement supply chain demand planning systems have the least economic

motivation. Going closer to the customer and focusing on the total flow of demand throughout the supply chain should increase the overall accuracy of demand planning. (Mentzer & Moon 2005)

This leads to the concept of demand management, which can be defined as *the creation across the supply chain and its markets of coordinated flow of demand.* [p.6] This incorporates the sharing of the traditional demand creating plans (e.g. demand created by marketing) with other functions within the company and possible other companies in the supply chain as well. Demand management also includes the assessment of the profit contributions of various products and customers and emphasizes the demand from the more profitable ones. (Mentzer & Moon 2005)

The difference between demand chain-led and supply chain-led organizations can be seen in the emphasis. The supply chain management has a bigger emphasis on efficiency, whereas demand chain management has a broader view of relationship management. In the supply chain management approach the management concern is more cost-led, though somewhat customer-focused. (Walters 2006) The same was noticed by Jurečka (2013): the strategic focus of the company has an impact on the process of demand planning: the leading organization and the means how it is done. (Jurečka 2013) In the demand chain approach it is important to notice the overlap in supplier and customer relationship management and realize that the effective way to manage these two is to integrate them. This often results in bringing conflicting objectives closer together, if implemented successfully. (Walters 2006)

Hilletoft et al. (2009) highlight that a completely implemented demand chain management approach should incorporate all the major demand creation and fulfillment processes. The goal of demand chain management is to develop synergies between the demand creation and the demand fulfillment processes. The demand creation processes include all the activities necessary for creating demand, which are often linked to marketing. They can include e.g. strategic marketing planning, market research, market segmentation, product development, product commercialization, marketing and sales and life cycle management. The demand fulfillment processes include all the activities necessary for fulfilling the demand, often closely linked to supply chain management. To successfully implement a demand chain management process, there important issues need to be kept in mind: the demand creation, demand fulfillment and the coordination between these two. (Hilletofth et al. 2009)

Demand planning is a **critical step in the S&OP process,** and, to many organizations, it can be **the most challenging one**. Future demand can be seen quite differently by different groups within the commercial side of the business, especially in the consumer products business. Different departments are also often viewing the business in different levels, which makes the combination of these views into a single, agreed-upon sales forecast challenging. (Wallace & Stahl 2008)

2.2.1. Timeline and planning level of demand planning

Demand planning and forecasting timeline can vary a lot according to empirical investigations on how far firms prepare their forecasts. The short-term forecasts are usually one month, whereas the longest forecasting periods can be up to 25 years ahead. (Winklhofer et al. 1996) In S&OP processes the planning horizon often ranges from 6 months to 3 years, varying by industry, product characteristic and the time of year when the S&OP planning takes place. The most common horizon is a rolling 6-18 months. Longer horizons are often used in industries that have long production lead times or high seasonality whereas shorter planning horizons are in use in industries with short lead times and low seasonality. (Grimson & Pyke 2007) The time horizon of the forecasting also has an effect on what the inputs used are. The long-term forecasting often focuses on macroeconomic variables (e.g. business cycles, energy and population) whereas mid-term forecasting focuses more on financial analyses and capital allocation decisions. The microeconomic research focuses on macroeconomic forecasts with industry-level forecasts as inputs. (Capon & Palij 1994)

When an organization operates in a **multi-item, multi-level environment,** it usually has to deal with a **great number of forecasts.** The demand plans are often needed in different levels depending on the function of the organization. (Wallace & Stahl 2008) Supply chain planning is often reliant on forecasts made on the stock keeping unit (SKU) level (Fildes et al. 2009). For an SKU, whether it's a part of a product family or if the same SKU is stored in different locations, the forecast can be made from the individual series' history or derived top-down. The time series for multiple SKUs are often related, usually caused by them being similar products. (Chen & Boylan 2009) When companies are producing products in a make-to-order fashion, the planning process can become more complex. (Grimson & Pyke 2007)

Demand planning processes vary depending on the product characteristics as well. Standard products with narrow variety are usually make-to-stock (MTS), whereas complex, customer-configured products are often make-to-order (MTO) or assemble-to-order (ATO). A level

planning strategy is usually used for the first one, while a demand chasing strategy is often utilized for the latter ones. In a demand chasing strategy the production output is changed to chase the demand whereas in the level strategy the production output stays in the same level and the fluctuations of demand can be seen in the inventory build-ups and depletions. (Olhager & Selldin 2007) A company having various products with different characteristics will have to identify its products and decide which demand planning strategies to use with which products.

When forecasting to the future, the forecasted time period often has three different time zones:

- the sold zone that contains only sold orders;
- the partial zone that contains some sold orders and some forecasted orders; and
- the unsold zone that contains only forecast. The process in this time zone is usually heavily involved with customer contact, trying to gain insight into their future plans. (Wallace & Stahl 2008)

When a forecast needs to be created, one of the key questions to consider is **on what level** the forecasting/planning should be done. The top-down method means the aggregation of lower level data to a higher level and creating the forecast for aggregated data based on the aggregated history, i.e. creating the plan on a high level and then disaggregating it down according to for example historical percentage shares. The bottom-up method on the other hand is conducted by creating a forecast for each of the lower level data series individually and aggregating these forecasts up to the wished level. The popularity of top-down forecasting is often based on the fact that the fluctuations of one data set may be compensated with another one and thus the variability of the aggregate data series is reduced. Top-down forecasting also requires less resources. However, the arguments against top-down forecasting often relate to losing the differing characteristics of different time series and the possible correlation of errors. (Widiarta et al. 2009; Schwarzkopf et al. 1988)

The top-down and bottom-up forecasts would perform equally well in a situation where the sub-aggregate components are uncorrelated and would have identical stochastic processes. The challenge in a real-life company environment when choosing a forecasting method is that the decision makers often don't want to spend too much time on examining and defining the characteristics of the data-generating process, which is required for example by the autoregressive integrated moving average (ARIMA) model. (Widiarta et al. 2009; Schwarzkopf et al. 1988)

2.2.2. Benefits of accurate demand planning and costs of inaccurate demand planning

Effective customer demand planning is one of the key drivers of a supply chain success. Poor customer demand planning can lead to **top- and bottom-line effects** which many organizations fail to recognize. Taking a top-line perspective, poor customer demand planning can lead to not being able to take full advantage of the demand of products and also to the failure in developing the supply chain to answer the demand. From a bottom-line perspective, the advantages of good customer demand planning include the minimization of inventory and other costs. (Mentzer & Moon 2005) Hilletoft et al. (2009) found that a critical factor to supply materials and products on demand is to keep the end-user in focus.

Supply chain collaboration usually leads to multiple benefits. Often collaborative forecasting enables either better customer service levels or a reduction in inventory. It also reduces the replenishment game by giving the supplier responsibility for replenishment. With supply chain synchronization there are even more benefits to be achieved, which include elimination of the bullwhip effect (Småros et al. 2003) and controlling the risk for constrained components or materials. (Holweg et al. 2005) The bullwhip effect refers to the fact that often orders to the supplier in a supply chain have a larger variance than the actual sales to the buyer. This variation also tends to increase when moving upstream in the supply chain. Information sharing has been found to be one of the key factors helping in overcoming the bullwhip effect. (Lee et al. 2004)

The different characteristics of the business and products guide the choice of supply chain collaboration strategy. If there is little geographical dispersion of customers and supplier plants, it is easier to implement synchronized production and inventory control. The dynamic benefits of eliminating bullwhip and synchronizing demand and supply in the system increase in relation to the stability of the product's consumer demand. The longer the selling period of the product is, the more sense it makes to consider collaborative practices. And the more valuable a product is, the higher benefits come from stricter inventory control. (Holweg et al. 2005)

The benefits of demand visibility and information sharing have also been questioned. Some have argued that order history available to the supplier provides the same information as information sharing if both the supplier and retailer know the stochastic properties of demand, which do not change over time. And that the benefit of reducing delays and replenishment batches exceeds the benefit of information sharing. (Holweg et al. 2005) This

can be true in some of the cases, but often the advantages of sharing information in the supply chain cannot be achieved by manipulating the operation processes (reducing delays and modifying replenishment batches). The historical information is not always the best indication of the future demand.

Ganesh et al. (2014) found that information sharing in supply chain management can:

- reduce the risk brought by asymmetric and incomplete information
- cut down lead time
- mitigate the bullwhip effect and
- reduce the total cost of supply chain.

Information sharing often also improves the accuracy of forecasts, which improves production scheduling and better management of consumer demand. The sharing of short- and long-term demand forecasts between manufacturers and retailers can be facilitated by collaborative planning and forecasting efforts. (Ganesh et al. 2014)

It has also been found that the effectiveness of supply chain collaboration depends on two factors:

- the level of integration of internal and external operations and
- the level of alignment of efforts in terms of the geographical dispersion, demand patterns and the product characteristics. (Holweg et al. 2005)

2.2.3. Demand planning process

Organizing the demand planning process can prove out to be difficult. The optimal process is company-specific, and there are no one-size-fits-all solutions available. What is known is that the demand planning side of S&OP has a **critical need of the involvement and commitment from the Sales**. Nevertheless it is often the case that the Sales do not see the benefits of forecasting and would rather spend their time actually selling than forecasting. (Boult 2014) To get a comprehensive view on the requirements for the demand planning process, it should not be seen as an individual element, but as a part of the S&OP process and also an integral part of the selling process. Thus the effective functioning of an S&OP process should be examined and then how the demand planning process inside the S&OP process should be configured.

Sales forecasting and planning requires information from various sources. To develop an informed forecast, for example the marketing plans and sales plans need to be taken into account. Numerous sources also need the statistical forecast at an appropriate level and suitable horizon to be able to develop effective plans. Thus to benefit from the sales forecasting, information systems need to be in place to facilitate the forecasting process and communication of forecasts and plans to other functions. Information systems and sales forecasting and planning should be intertwined with each other and other business functions to manage the business successfully. The flow of information should not be only one-way: from demand to supply. In order to develop plans that are the most efficient and profitable, the **flow of information** needs to go both ways. The information from Finance to Sales about the profitability differences of products can have an impact on the actions from Sales and the information from Operations about shortages of materials should inform the Sales not to sell products that cannot be manufactured. (Mentzer & Moon 2004)

In order to function properly, the demand planning process requires the **commitment and interest of top management** (Boult 2014). The support shown by the management often also tells the lower levels of the organization that the process is valuable (Hobby & Jaeger 2013). The demand planning process often takes place on monthly bases, although the proposed frequency of meeting ranges from daily meetings to event-driven when-needed meetings. The choice of frequency should be chosen based on how dynamic the market is and how dynamic the production environment is. (Grimson & Pyke 2007)

The demand planning phase in S&OP often includes:

- the statistical forecasting and its review and aggregation
- forecasting of new products
- forecasting of new order volumes (especially in make-to-order companies)
- application of external factors
- financial conversion and
- executive authorization.

(Wallace & Stahl 2008)

The demand planning process is concentrated on the side of the organization that faces the customers. The future demand can be predicted for example from scheduled customer orders or by extrapolating demand from the main market conditions or from the demand-

influencing activities of the organization or its competitors. Support for decision making can come from quantitative models, decision support systems or by outsourcing the planning to third parties. (Oliva & Watson 2011) **Different approaches to forecasting** can be taken, depending on the industry- and organization-based characteristics. According to Mentzer & Moon (2005), the sales forecasting process includes the sales forecasting management, systems and techniques. Sales forecasting management refers to the approach taken to manage the forecasting/planning process, techniques refer to the choice between different techniques used (e.g. time series, correlation analysis and subjective forecasting) and systems refer to the analysis and communication templates laid over the whole forecasting process. (Mentzer & Moon 2005)

In the study made by Oliva and Watson (2011), they found that the demand forecasting process of their case company was consensus forecasting, which the case in other companies is often as well. Three different forecasts were used as a basis for the consensus forecast. Those forecasts were the product planning and strategy; sales directors' forecast; and the demand management organization's (DMO) forecast. The DMO's forecast was based on statistics from past sales by region and this was used mostly as a reference to the two other forecasts. The product plan was made top-down and it took into consideration the product roadmaps whereas the sales directors' forecasts were made bottom-up by aggregating the account managers' information about current sales, expected promotions etc. The DMO would then combine these forecasts placing more weight on the sales directors' forecast in the near future and increasing the weight of the product planning forecast in the longer time horizon. (Oliva & Watson 2011)

2.2.4. Demand planning systems

The use of computerized forecasting systems to produce initial forecasts is the most common approach to forecasting demand in supply-chain companies. After the initial forecast the company's demand planners can do their subsequent judgmental adjustments. (Fildes et al. 2009) The interest in research concerning demand chain management has been partly caused by the emergence of a significant number of information systems claiming to support the demand chain management concept (Van Landeghem & Vanmaele 2002). Forecasting/planning systems range from isolated databases to fully integrated systems and communication tools. These tools with e.g. web-enabled interfaces can be used to facilitate forecasting and planning collaboration with key customers and suppliers. (Mentzer & Moon 2005) The format of the interface of a forecasting support system can improve accuracy.

Good baseline forecasts and accuracy monitoring are important to gain a good end result. (Fildes et al. 2009)

A well working planning process can function **with or without an advanced planning system's (APS) support** (Ivert & Jonsson 2010). Thus, a forecasting/planning system should not be developed without the understanding of the demand management process (Mentzer & Moon 2005). It does not matter how well a planning system was selected or implemented if it is not used (Ivert & Jonsson 2010). Many of the software implementations have failed because the process in which the system was supposed to be used was not kept in mind well enough and no standard workflow was introduced to connect the system to the existing process. An integrated approach that provides collaborative workflows between the human and the system and between different parties in the process helps in streamlining the planning flow through the organization. (Makatsoris & Chang 2004)

A planning system can benefit the demand planning process of S&OP. It can support in making various demand forecasts by using different forecasting methods. Planning systems often also provide a possibility to integrate the views of different departments and thus facilitate the creation of a consensus forecast. In the planning tools the aggregation and disaggregation between various levels aids the possibly numerous people in providing them a possibility to see the information on a level that is familiar to them. (Ivert & Jonsson 2010)

What comes to the features of a forecasting/planning support system, a possibility to add remarks related to the changes made to the forecast/plan is important. It might reduce the number of relatively small but damaging adjustments that may be based on misinterpreting noise as a signal or reflect gratuitous altering of forecasts. A list of reasons for the modifications can also improve the quality of judgments based on market intelligence, help assist in the decomposition of market intelligence and lessen the likelihood of double counting as well as allow forecasters to understand why the market intelligence is so often misinterpreted. (Fildes et al. 2009)

Overall the benefits of the utilization of an advanced planning system have been found to include: better decision making, overall cost savings, less capital tied in the inventories and reduction in planning time. **However, the greatest benefits that Ivert and Jonsson (2010) found were intangible.** They found that the use of a planning system improved the communication between different business functions and helped the managers to understand the cost and service implications of proposed network alternatives and raised people's awareness of an ability to act on supply chain issues. (Ivert & Jonsson 2010)

2.3. The creation of a demand plan

A detailed analysis of over 60,000 forecasts and outcomes from four supply-chain companies made by Fildes et al. (2009) showed that **for three out of the four companies judgmental adjustments made to the initial forecast by the company's demand planners increased accuracy**. Nonetheless, they also found that while the larger adjustments tended to lead to greater improvements in accuracy, the smaller adjustments frequently damaged the accuracy. The adjustments made by demand planners were also often made in the wrong direction, showing a bias towards optimism. Research has shown that while judgmental adjustments seem to improve accuracy, they also often introduce bias to the forecast. (Fildes et al. 2009)

There is a huge variety of forecasting techniques that companies can use to forecast the future. Over 70 time series methods have been found, and the range of different methods can cause decision makers to give up hope on understanding all the techniques. This can make the decision makers to instead focus on a few methods that they find familiar, whether those techniques are appropriate for the situation or not. The methods are often categorized based on whether they use subjective or statistical analysis; whether the data analyzed is endogenous or exogenous; and whether the data is analyzed by a forecaster or if it is an input into a technique of forecast calculation. **Three categories can be formed based on these characteristics: time series, regression and judgmental**. (Mentzer & Moon 2005) Time series and regression models use different data series as inputs for the demand equation, whereas judgmental forecasting/planning involves the human information in the forecasting/planning process.

While there is extensive research showing that quantitative forecasting methods are superior to qualitative methods in most of the cases, various surveys of sales forecasting practice have shown that qualitative methods are still more widely used. (Davis & Mentzer 2007) In many companies a combination of both qualitative and quantitative measures is used.

Even though the techniques used in the forecasting and planning processes are important, **the people making the forecast and plan have a critical role.** Thus as the people in the process are the sources of forecasting and planning intelligence, they should be trained to make the most of this intelligence. In a study made by Moon et al. (2003), they found that in most of the companies the people involved in the process had had **no training** on why forecasting is important or **how to** actually **make qualitative adjustments** to the baseline forecasts. The demand planning systems should support the planning process, eliminating

multiple processes performing similar tasks, integrating the planning system to other corporate systems and standardizing a single set of forecasting processes. To improve the accuracy of forecasts and plans, continuous measurement of performance should be in place. This would include for example giving the Sales people feedback about the accuracy improvements of the judgmental adjustments that they have made. (Moon et al. 2003)

2.3.1. Statistical forecast

Since the number of needed forecasts in the SKU level is often large and the demand planners cannot manage them all individually, organizations often use **a statistical software system** to create an initial forecast (Fildes et al. 2009). Substantial advances have been made over the past three decades in developing the sales forecasting techniques that reflect market place conditions. Nevertheless, only marginal gains in sales forecasting performance have been reported in surveys of sales forecasting practices. This suggests that there is a gap between theory and practice and that the organizations have not always been able to take advantage of the benefits possible to get from statistical forecasting. (Davis & Mentzer 2007)

As the number of products/product variants is often high, it has been suggested that automatic statistical systems should be used for the products that are not high in value or are difficult to forecast (Bogdashov 2014). **Time series techniques and correlation analysis** can be used when the basic assumption is that the **historical demand** may follow some **patterns** and that those patterns will **stay the same** in the future. They also require less effort than qualitative (subjective) techniques, which makes them useful for e.g. product level volume forecasting where the human experience would add little or none value. (Mentzer & Moon 2005)

Time series techniques are one of the ways to use history as an input for the forecast. Open model time series (OMTS) techniques (e.g. Box Jenkins) analyze the sales history and build a forecast after identifying the existing patterns in the history. Level, trend, seasonality and noise are the four data patterns that can be found in the history and the forecast is based on their interrelationship.

- Level is the sales pattern that would exist, if there was no trend, seasonality or noise.
- Trend is the continuing pattern of sales: increase or decrease, straight line or a curve.
- Seasonality is a repeating pattern of increase or decrease in sales.
- Noise is the random fluctuation, the part of the sales history that the time series technique can’t explain.

Quite a lot of research has been done on open time series techniques, but they have not been a great use in business due to their complexity and limited incremental accuracy comparing to other models. Fixed time series techniques differ from the open techniques in the sense that they use a priori assumptions on the patterns found in the data (level, trend, seasonality and noise), which makes them easier to use. (Mentzer & Moon 2005)

Regression (correlation) analysis can be used as a statistical forecasting method when trying to find the relationships between sales and exogenous variable that affect sales (e.g. advertising, product quality, pricing). If strong relationships are found, the correlating variables can be used to forecast future sales. Correlation analysis is possibly the most accurate forecasting method, but it requires substantial amounts of data. (Mentzer & Moon 2005) A summary of the different statistical forecasting methods can be seen in Table 3.

TABLE 3 SUMMARY OF STATISTICAL FORECASTING METHODS

	Open Time Series	Fixed Time Series	Regression (/Correlation) Analysis
Input used	Endogenous (inside the system, e.g. historical data)	Endogenous (inside the system, e.g. historical data)	Exogenous (outside of a system, e.g. advertising)
Inputs analyzed	During the process	Before the process	Before the process
Usability	Complexity reduces usability	Easier to use than open time series	Requires substantial amount of data

One of the essential factors when considering statistical forecasting is the data quality. The generally known "Garbage in, garbage out" rule demonstrates the consequences of forecasts made on low quality data. The historical data should be cleaned of noise to eliminate the spikes caused by e.g. promotional events. (Sagar 2011)

2.3.2. Judgmental adjustments

Information about market and environmental conditions should be examined when developing a sales forecast. Determining the marketing and sales efforts that are required to meet or exceed sales projections will result in a demand plan. (Mentzer & Moon 2004)

People have been found to have a limited capability to express intuitive knowledge or deep expertise explicitly. This shortcoming can be compensated by collaborative and structured dialogic approaches that will facilitate the coherent group reasoning and capture diverse perspectives. (Weigand et al. 2013)

Collecting different inputs and taking a **collaborative foresight approach** to planning helps managers in making better fact-based decisions. It will enable the gathering of a collection of most relevant knowledge to inform the complex situations of long horizon planning. (Weigand et al. 2013) The qualitative insights that can be used to enrich the quantitative statistical baseline can be gathered from inside and outside the organization (Sagar 2011). They should also be a regular part of planners' responsibilities (Eroglu & Knemeyer 2010).

The statistical forecast based on the **history data cannot always foresee the changes** in the environment, client base or competitors' actions, which is why the judgmental adjustments made by humans are often needed. The judgmental adjustments can be related to e.g. the market conditions, the customer information or information from distributors, project information or product roadmaps.

Market intelligence

Judgmental adjustments made to the initial forecast are often based on market intelligence. When information about the market is quite certain and its direction is clear, there is major potential for improvements in accuracy. Nonetheless**,** the process of gathering market intelligence is often flawed and **lacks coordination and communication** between different organizational units. The information collected is not often stored in a database which would increase the possibility to learn through analogy from earlier examples or increasing the understanding of the current situation. (Mentzer & Moon 2005)

The improvement of forecasting environmental factors had received considerable amounts of research already in the 1980s. The more accurate forecasts of the environmental factors should also benefit the accuracy forecasts about the market. But surprisingly it has been found that highly accurate environmental forecasts are not required to gain accurate market forecasts. (Armstrong et al. 1987)

Business cycles of different countries have been found to be reflected in similar patterns in almost every macro-economic variable, showing their interdependence. Thus the leading economic indicators can be used to forecast the business cycle of a country. It has been found that with the help of these indicators the business cycle in manufacturing is possible to be

forecasted fairly accurately for four to six months ahead. This is not restricted to national macroeconomic variables, but is a global phenomenon. (Berk & Bikker 1995)

Leading indicators enable the prediction of cyclical movements in business cycles, being the time series that lead the general business cycle. These various leading indicators can be combined into a single leading business cycle index. The use of composite leading indicators started already in 1919 when an *index of speculation* was created in Harvard University. This approach has spread and the composite leading index is in use in almost every industrial country. In many countries considerable interest is attracted by the publication of monthly indicators. (Berk & Bikker 1995)

At the moment some of the commonly utilized market indicators include the previously mentioned *Leading Indicators* by OECD that are combined from various different inputs and which have already been found to correlate with general business cycles. In addition to that, one of the often used indicators is the Purchase Managers' Index (PMI) which is combined from the answers of purchase managers all around the world about their previous month's situation. The answers to the questions are in the form of lower/same/higher, in order to be able to gain data that is close to hard data without having to worry about asking non-public information from the companies. This PMI indicator is combined globally and for various geographic areas to get a view of the current market situation and development. (Lahiri & Monokroussos 2013)

Customer and distributor information

One of the focal goals of a company is to have their products at a right place at a right time, and one of the key requirements in achieving this is a good forecast. As the product, time and place all depend on the **end customer,** this is where the forecast should begin. The end customer demand will then be translated into distribution center demand, which in turn will be translated into a factory demand plan. These translations are driven by the inventory policies of the different layers being forecasted. (Sagar 2011)

Collaborative planning, forecasting and replenishment (CPFR) is one of the key concepts in the collaboration between a company and its external partners. The objective of CPFR is to increase the accuracy of demand forecasts, lower the necessary inventories and increase the service level of a company. (Makatsoris & Chang 2004) CPFR has also been connected to providing a rich continuum of strategies that help the collaboration among supply chain partners. Other collaboration methods include Efficient Consumer Response (ECR) in the fast moving consumer goods sector and Vendor Managed Inventory (VMI). (Holweg et al. 2005)

The goal of CPFR can be defined as combining information from multiple sources and improving the coordination of supply chain activities between trading partners by acting on demand plans. (Eroglu & Knemeyer 2010) Although it is generally accepted that the creation of a seamless supply chain leads to benefits for the company, including increased responsiveness and lower inventory costs, the implementation of the CPFR processes has been less common than what could have been thought. This might be due to the fact that the collaboration practices are not well-defined: to some they mean holding consignment stock while to others they represent a complete philosophy of stock keeping and the control over multiple tiers of a supply chain. Also the ways of how to benefit from external collaboration and the use of demand visibility are often not well understood. (Holweg et al. 2005)

Even though the research on supply chain structure usually suggest that co-operation between the customer and supplier could result in great benefits, the question of when a customer would be willing to give access to real demand data has risen (Heikkilä 2002). Many companies are **unwilling to share information** with their trading partners, afraid of unfair usage of the data to the partner's advantage (Ryu et al. 2009). The understanding of conditions for a win-win relationship has been researched, and there has been a suggestion that companies should divide their customer-supplier relationships into classes to differentiate true partnerships from more distant relationships. Although true partnerships create additional value, they are **costly to develop and maintain.** Heikkilä (2002) suggests that several demand chain structures are necessary to adapt to varying customer needs and situations.

Introducing collaborative planning into existing relationships might be hard when the customers are used to getting what they ordered when they ordered it**.** But when the **market situation gets tougher** and suppliers are having troubles in delivering what the customers require, **the collaborative planning is easier to implement.** (Boult 2014)

The benefits of information sharing have been shown to include the ability to address problems arising from the bullwhip effect, the possibility to take advantage of sales trends and better inventory management (Ryu et al. 2009).

For many companies the only factual demand information they have are the orders placed by their customers and the **lack of demand visibility** has been identified as an important challenge for supply chain management. Order information often gives a delayed and partial picture of what is happening in the market. The distortion can increase the upstream in the

supply chain and make the demand look variable and unpredictable, resulting in the bullwhip effect. (Småros et al. 2003)

Product management

An important aspect of business planning is the integration of technological considerations into business strategy. (Phaal et al. 2004) Technology management deals with various aspects relevant to integrating technological issues into business decision making. The focus should be in managing the new and existing technologies to ensure a stream of products to the market. (Farrukh et al. 2003) **Product roadmaps** are often a combination of forecasting and planning, since they combine the forecast of what could happen and the strategic plans that express the action. Business unit managers possess market insights as they are closer to the real customers and products. (Kappel 2001) Thus the development of the product portfolio and the technological roadmaps are also important inputs as judgemental human adjustments in the demand planning process.

Technology roadmapping is often used to support the long-term and strategic planning of a company. It is a flexible technique that provides structured means for exploring and communicating the relationships of different products over time. It may include for example the relationships between evolving and developing markets or different products and technologies. (Phaal et al. 2004) The technology roadmapping is a combination of established disciplines such as technology forecasting, strategic planning and other activities that emphasize future activities (Kappel 2001). Strategic planning has also been found to benefit technological, market and new product development marketing alignment positively. (Acur et al. 2012)

The roadmapping can be seen from two different perspectives. First is the perspective from the company's point of view: the assessment of new technologies and market developments and also the technology developments to be integrated in the business planning. Second is a larger, multiorganizational perspective: roadmaps to show the environmental landscape and the threats and opportunities for a certain group of stakeholders in a technology area. (Phaal et al. 2004) The essence of business strategy and planning can be thought to be in aligning the activities and resources of a firm to sustain a competitive position in the market place (Farrukh et al. 2003). Thus the technology and product management inputs are also an important factor to consider when doing demand planning, especially in long term planning.

2.3.3. Projects

The information gotten from the sales pipeline is often not integrated in the demand planning process, though it could provide valuable information. Three phases can be identified in the sales cycle before the receipt of the purchase order. These are the lead qualification, which includes sales qualified leads and prequalified leads; evaluation, which includes quotation and assessment of needs; and finally the negotiation and offer phase where e.g. technical discussions and price negotiations take place. **This sales pipeline can be utilized as a useful input for the demand planning process.** In order to be able to do that, the average conversion rates from different phases to real orders need to be calculated. (Bhattacharyya 2014)

2.4. Conclusion from the literature review

Demand planning is one of the key ingredients of a successful planning process nowadays. The market is changing to more and **more customer-oriented**, while previously industries often operated more in a supply driven way. (Burrows III 2012) Products are configured to answer to customer needs and thus customers are in the power position. This is true in a lot of industries, which has had an effect on the design of how operations are run in companies. Planning and forecasting future demand is critical to be able to answer **the fast-changing needs of the market** and to take advantage of the possibilities in the market.

Cross-functional collaboration is needed in order to be able to operate effectively and to be able to catch the demand in the market. It's not enough anymore to have Operations run the show, nor is it enough to have only Sales and Operations run it together. Now also Finance and top management should be involved in the process to get all the advantages of well-functioning cross-company planning operations. (Ivert & Jonsson 2010) This can be challenging in large global companies with operations and stakeholders in multiple countries. Sales and Operations Planning has evolved to answer this need of collaboration throughout the company. Demand planning has often been seen as the most critical part in the success of S&OP (Wallace & Stahl 2008), since the operations can only be as good as the plan (Burrows III 2012). Since plans can't always be correct in today's fast changing environment, in the operations side there should be some flexibility to answer the changes in the actual demand.

However, quite accurate forecasts and plans can help companies in challenges related to for example long lead times in materials to be purchased, planning the product portfolio, capacity planning and to giving more accurate forecasts to suppliers to avoid the bullwhip effect in the supply chain (Ganesh et al. 2014; Holweg et al. 2005). As has been found, the need for companies to start S&OP and demand planning processes stems from different sources, which leads to the fact that **there is no one-size-fits-all process**. Therefore the process should be developed individually to answer the specific needs of companies. However, **characteristics of a good S&OP process can be identified**. Thomas F. Wallace and Robert A. Stahl for example have written various books in the past decades to help companies grasp the idea of Sales and Operations Planning. Many different variations of S&OP have also been developed ranging from "market-savvy" S&OP (Burrows III 2012) to integrated business planning (IBP) and other similar processes (Jurečka 2013).

A large company operating efficiently and effectively in a global environment needs to consider various aspects in planning its planning process. The process of how the plan is made is one of the most important things to consider:

- how should the flow of information be organized to arrive to the best one-number forecast
- who are the people involved in the planning process
- who are the people who use the plan
- how to get people to commit and prepare for the planning
- what is the goal of forecasting and
- how to make people realize their role in the wide process in order to be able to comprehend the importance of each task and to see the big picture.

In addition to the process from the people view, also the concrete process of the development of a plan should be considered:

- is there a statistical forecast as a baseline
- what is the level where the plan is formulated
- what are the inputs used to adjust the forecast in order to better reflect the future
- who are the people who possess relevant information and
- who owns the plan and has a final say in the demand planning process.

The timeline of the plan should also be considered, as well as the level of plans and the frequency of planning. The timeline of planning is often company specific. To be able to consider strategic decisions in addition to tactical ones, the **timeline needs to be close to two years or longer** (Alexander 2013). This helps to grasp the differences between the strategy and the realistic and up-to-date plan, and relates also to the financial plans and budgets. This also helps taking into consideration the technological product roadmaps and thus helps in planning the ramp ups and ramp downs of products. (Kappel 2001)

Since the product portfolios have become more and more complex and frequently include products that are configured based on customer wishes, it is not often feasible to make demand plans on a stock keeping unit (SKU) level (Fildes et al. 2009). More often a statistical forecast based on the history data is formed, which can be aggregated and disaggregated to various levels to give a relevant view for different people who are interested in different views. This can include Product Managers looking at the global data per product line, Sales Managers looking at the sales of a certain area, Operations Managers taking a look at the

planned demand for a certain factory or Financial Controllers reviewing the sales and future plan of a certain business unit (BU). This way for example if an area manager knows that the business is picking up in one of his countries, he can adjust the plan on the country level and that adjustment is then applied to all levels. This helps the people involved in grasping the bigger picture and making the process of forecasting not require too much analytical skills.

The possible judgmental adjustments that cannot be seen from the history involve the changes in **customer behavior,** the changes in the **market,** the growth of **market share** and different kinds of **project information.** Most studies have found that the judgmental adjustments on statistical baselines often increase the accuracy of the forecast, especially when the adjustment is bigger, and not a small adjustment that can be made based on feelings. The judgmental adjustments often introduce bias to the forecasts and the planned figures are often higher than the actuals. This bias can be lowered by always having to communicate why the plan was changed. (Fildes et al. 2009)

The demand planning process and systems should be developed to support the **transfer of information** and **creation of the plans**. In the process key ingredients are the management support and the commitment of the people involved. (Boult 2014; Hobby & Jaeger 2013) To be able to have people take part in the planning process, the benefits of it need to be comprehended and the big picture should be seen. Before implementing planning systems the planning process should also be already in place. (Mentzer & Moon 2005) The planning systems can support the process by making the information available easier, eliminating manual work and illustrating the numbers in an easily comprehensible graph. (Ivert & Jonsson 2010; Wallace & Stahl 2008)

3. Benchmarks

In addition to the literature review, five companies were benchmarked to gain insight on the different demand planning processes and relationships with strategic planning and the top management decision making. The benchmark cases were found useful, since as the literature review revealed, the demand planning and S&OP processes are typically modified to suit a company's needs. (Wallace & Stahl 2008) For many companies it is an issue to make the theory work in practice and different solutions have been developed. Even though the processes might be different, many of the same challenges are still present. The same core of the process can often be identified, but different emphasizes can be found. These are often results from differing businesses, company characteristics and key issues that have led to the introduction of S&OP.

The benchmark companies were selected based on **theoretical** sampling instead of random sampling to find benchmarks that would either **replicate or extend the theory** base related to the situation of the case company. Thus suitable companies of which there was already some knowledge about their S&OP processes were considered. The best candidates were contacted and one interview was conducted in each benchmark company. The interviewees was chosen based on their position in the company, focusing on people in the core of the S&OP processes of the company. The interviews were conducted as a semi-structured interview with open questions and four out of the five interviews were recorded in audio and the fifth one in written form.

The same structure was present in all of the interviews, though the focus differed depending on the position of the interviewee and the characteristics of the company. The interviews lasted from 60 to 90 minutes.

The S&OP process is present in all of the benchmark companies in some form, but the term used for the S&OP process varies. To make it easier to follow the thesis, the term S&OP will also be utilized concerning the different sales and operations planning processes of the benchmark companies.

In the following section the five benchmark companies will be introduced and their demand planning and its relationship to top management's decision making will be discussed. The sections are based on the interviews made in the benchmark companies. Table 4 summarizes the key characteristics of the benchmark companies, which will be discussed further in the following subchapters.

TABLE 4 SUMMARY OF BENCHMARK COMPANIES

Benchmark company/ Topic	Company A	Company B	Company C	Company D	Company E
Industry	Industrial machinery	Industrial manufacturing and service	Tele-communications	Food	Healthcare
Position of interviewee	S&OP core team /Operations	S&OP core team	Region demand plan manager	S&OP core team	Supply chain management
Challenge	Labor capacity planning	Material planning	Materials and capacity	No unified process, no structured planning	Resource level, long term planning
Product characteristics	Mostly ETO	Ranging from volume to CTO and ETO	Mostly standard products	Standard products	Mostly standard products
Focus of S&OP	Capacity	Materials	Capacity	Products, demand	Resources (=capacity)
Source of forecast	History data, project information (Previously also sales forecasts)	Volume: Sales offices Projects: Sales funnel	Customers	Key Account Managers per business areas	Booked orders, known tenders from Sales
Time horizon	Rolling 5 quarters	Rolling 4 quarters/12 months	Rolling 13 months	Rolling 18 months, to be 3 years	Rolling 4 quarters
Owner of plans	No clear ownership /Operations	Sales	Sales (Head of the Customer Business Team)	Sales (KAMs)	No clear ownership/ S&OP team

As can be seen from the Table 4, the benchmark companies vary in some aspects. The industries range from food and healthcare to industrial manufacturing and machinery, and the planned products vary from standard volume products to products that are make-to-order (MTO), configure-to-order (CTO) and engineer-to-order (ETO). Most of the companies sell B2B and only one of the benchmark companies is in the consumer business. The interviewees range from members of the core S&OP team to a region demand planning manager and to supply chain management. This has provided multiple insights from different viewpoints and offered useful additions to the literature review.

3.1. Benchmark A

3.1.1. Introduction to Company A

Benchmark Company A is a global industrial process performance provider in the industrial machinery industry. It has customers in various industry segments. It sells business-to-business (B2B) and its products are typically engineered-to-order (ETO). The lead times of orders vary and although indications of projects can be received early on, once an order becomes certain, there is already a hurry to fill it.

The S&OP process has been introduced in Company A already in the 1990s. However, the process has been organized **in various ways** and with **different levels of effort and commitment**. The process was discontinued at a certain point, but re-introduced when operational challenges arose. The person interviewed is a manager from Operations who has led the S&OP process. At the moment the S&OP process in the company is subdued, not being top priority for the management. The company has been found to function quite well also without a full-effort S&OP planning process. Nevertheles**s, the rise of some operational challenges** might lead to an introduction of a stronger S&OP yet again.

Reasons why Company A has used S&OP include the need to be able to **plan the labor capacity** efficiently and to **forecast capacity allocations from suppliers**. Operations is the main user of the outputs of the S&OP process, which has made the process quite Operations-led, lacking the ownership of Sales. The needs of Operations include the project resource planning, rough capacity planning, supplier forecasts and item level forecasts. These all require a view of the future: what will the demand be and how should the operations be prepared in order to be able to meet it. The benefits Company A has gotten from S&OP include **more transparency** into the process and **increased accuracy** in the forecasts to bigger suppliers**.** The cost of lost sales is hard to demonstrate, so it has not been measured how S&OP has succeeded in making the whole sales and production process more efficient and in helping the company answer the possible demand better.

The strategy makers use the S&OP plans as an input, but there is no clear feedback loop with which to gain insight on whether the plan is aligned with the strategy or whether there are some bigger opportunities or risks in the bigger picture that should be taken into account.

3.1.2. Demand planning process in Company A

In the demand planning process the inputs come from various sources, although the demand planning process has experienced a change in the past few years. The Sales used to provide inputs monthly, including the forecast of the future and comments about the current sales. From product line managers, the information received concerned the industry knowledge and the product line managers were planned to take a bigger role in the future. The capacity information of factories was gotten from Operations, to consider the implications of demand on the lead times of products. In addition to these, the historical order intakes and quotations from the project base have also been utilized when making the demand plan. No market indices were formally in the inputs of a demand plan, though they might have had an impact on the forecast provided by Sales. The numerable information sources and stakeholders of S&OP can also be seen from the number of people attending the S&OP meetings. In the quarterly meetings the Sales Area Manager and Financial Controller are present, whereas frequently in the monthly meetings there are also the leaders of product lines, the person in charge of projects, and the management team of the factory (e.g. stream leaders, factory manager, purchasing personnel, factory planning responsible.)

Currently the **Sales department** is **not heavily involved** in the S&OP process. They are asked a few times a year to provide strategic numbers, meaning the sales target. In history it has been proven to be the case that Sales has not been able to provide accurate forecasts, so now the process is more focused on the information from the history and from the product line managers.

The S&OP process in Company A is done on monthly basis and the timeline for plans is five quarters. The accuracy is followed by combining the plans made for a certain month and calculating the accuracy by giving different weights to plans made in different time horizons. E.g. accuracy of the plan for July takes into account the plans made from one month before up to plans made fifteen months before July. This way the sub-optimization is decreased and the coherent planning in the whole time horizon is encouraged. At the moment the S&OP plan does not have **clear ownership**, which is an issue since there is no clear accountability of, for example, the accuracy of the plan.

The main challenges in the S&OP process in Company A include the **lack of commitment** from both **Sales** and the **top management**. The forecasts are hard to get from Sales and they can include some misinformation, e.g. projects that are “saved” to fill a later target and thus reported later than when the information was gotten. The lack of commitment from the Sales

is partly resulting from the fact that the benefits to them of an accurate S&OP process are hard to demonstrate. The quantification of the benefits of shorter or more accurate lead times or better deliveries can be challenging to do in a complex environment.

There is an attempt to answer the challenges coming from the Sales department with a new CRM system which should ease the role of Sales. The new system should help with the availability of information, so that numbers don't need to be always produced for the monthly basis of S&OP, but they are always available. The **CRM system** is hoped to help also in making Sales commit to the numbers they are providing. Since it is their own system, the commitment to the figures should be present more easily. The system should also assist in the analysis of the historical numbers, which has previously been made by the Operations.

3.2. Benchmark B

3.2.1. Introduction to Company B

Benchmark Company B is also a global company in the manufacturing and service industry that provides solutions to business customers. Its customers are based in different industrial sectors and the products of Company B vary from standard volume products to configure-to-order (CTO) and engineer-to-order (ETO). This provides challenges to the planning process since the variation of products is large and lead times of the products can vary from few weeks up to a year.

Historically financial planning has been strong in Company B and this is why the demand forecasts from the sales offices are done in currency as well. It has also been tried to be done in quantity but it proved out to provide less accurate plans. Financial planning also increases the commitment to the plans when comparing to the quantity level planning. This is why the plans are made in currency and the global team then translates them into quantity based on historical information.

The S&OP process was started in this company approximately three years ago. The interviewed person is the Head of Planning and has been involved in the S&OP process from the start, being one of the members of the global core team. The link to strategy from S&OP is more one-way and while the management gets reports of the plans, there is no feedback loop back. The S&OP process takes more feedback from the annual (budget) planning than vice versa.

The main reason for starting the S&OP process in Company B was to guarantee the **availability of required materials** to be able to answer the customer demand effectively and efficiently. The low inventory turns and the number of materials that have a lead time of four to six months while the products of Company B be might have lead times of two to four weeks makes the planning of future demand critical. With the help of the S&OP process, Company B has been able to decrease the bullwhip effect in both inside and outside of the company by **improving its communications**. **The commitment to the process** is good in the management review phase and also the commitment from Sales is good.

The accuracy of plans is measured comparing the actual demand to the plan made six months before. This accuracy is systematically followed, but is not tied into any bonus systems. Even though the accuracy can be seen on global level, the most important level for Company B is to see the accuracy per factories, showing the differences between different regions.

Since the S&OP process in the Company B is quite young, the system integration has provided some challenges. At the moment there is a global framework but different planning modules for different products. A big global ERP project is ongoing and the new CRM system has recently been taken into use.

3.2.2. Demand planning process in Company B

As usual in the S&OP process, the Company B also has various inputs that affect the plans. Company B utilizes different planning methods for its volume products and highly intermittent project business. The project business is planned with the help of a **sales funnel** while the volume business is planned mostly with the inputs received from the Sales. The sales offices give their forecasts per quarter (in the future per month) mostly in money, which the global core S&OP team will translate into pieces with the help of historical average prices.

The core of the demand planning process for Company B can be found in the country level. It gets forecasts from all of its forty six operating countries and these are the basis for the demand plans for the volume business. This process has increased the accuracy of the plans and thus increased the trust level of the people who utilize the plan. Since the basis of the demand plans are in the forecasts gotten from the sales units, no macroeconomic indicators are used in the process, unless the sales offices have implemented them in their plans.

The global core S&OP team does not modify the forecasts made by the sales offices. The forecasts will then be reviewed in an aggregated level by Business Units, which might adjust the plan if it does not view the plan as realistic. However, **sales offices have a clear ownership** of the forecasts. This kind of planning process functions well when the demand is quite stable.

For the project business Company B utilizes a different approach to planning. The quotations are followed in the customer relationship management system (CRM), and once the probability of winning the quotation is high enough (>60%), it is considered to be added in the planning process. Then the people responsible of the “hot offers” are contacted, and the offers that are the most likely to go through are taken into the planning process as well. About 25% of the hot offers are included in the demand plan. The process works well for the project business, since the Sales are committed to using the CRM system. More focus has been put in previous years to the unification of processes, so that for example the probability of 60% is understood similarly across the organization.

The planning process for the project business is more manual than for the volume business. But since there are about 200 projects per year, the amount is still manageable. Some of the projects have such long durations that the materials can be purchased after the project is already won. These would not need to be planned since the materials can be bought based on the actuals. But the planning of projects increases the view on the future and is thus good to have included in the planning process.

The demand planning process of Company B is done monthly and the timeline for the forecast is 12 months (and for the sales the rolling four upcoming quarters). After the management review in the end of the S&OP process, the plan is frozen. The freeze time varies and is usually relative to the order delivery time. Thus for the products that have a delivery time of approximately 2-6 weeks, the freezing time is about a month, whereas for the products which have a delivery time of more than 2 months, the freezing time is one to three months.

3.3. Benchmark C

3.3.1. Introduction to Company C

The benchmark Company C is a global high tech company. The S&OP process has gotten more focused in the few previous years and is in a phase of continuous improvement. The process is based on bottom up planning relying on sales targets. The process has direct involvement from the **customer teams, regional teams and global teams.** The demand plan is done for rolling 13 months, which is divided into short term and mid/long term. Short term consists of the exact planning of the first 3 months and mid/long term planning is concentrated on the planning of supplier capability and capacity for the next six to thirteen months. The interviewee of Company C is the Region Demand Manager.

The benefits received from the S&OP process include e.g. having **better insight into material and capacity planning**. In the scope of the planning there are all the volume products, of which the key items are used as main indicators. The planning is done on configuration or key sales item level and the plan is developed according to sales funnels, ongoing tenders and the roll-out requirements within the planning horizon.

The S&OP plans are followed carefully to be in line with the business strategy. The ongoing activities happen at customer team level and these are communicated upwards in the organization. This helps to get accurate and up-to-date information from the customers to support the timely planning of projects. Very relevant aspects in the planning process are the ramp up plans of new products and the ramp down plans of old products. These plans are aligned together with the Business Units.

Each of Company C's customers have a signed contract and an assigned customer team. Volume forecasts for Company C's demand plans are done by its customer teams, and since all of its customers have a customer team, no demand should be missing from the plan. The customer teams have a forecasting meeting once a month, in which the forecast for the upcoming months is discussed and agreed on.

3.3.2. Demand planning process in Company C

The products in the planning scope are **volume products**. Configurations are planned according to real customer need and request, and the product portfolio is updated when needed. The whole configuration is then added to the demand planning tool. For higher level planning and quality follow up some key items are used.

The demand plans in Company C are made on **customer level**. The regional planners look at the data aggregated to region level, whereas global planners look at the total data per product lines. It is the responsibility of each of Company C's customer teams to produce a good quality forecast that is then approved by the Head of each Customer Business Team. The timeline of the plan is rolling thirteen months, although it has been found that the most accurate forecasts from the customers are received for the first three to six months. The regional planners' role is to do regional adjustments in the plans if/when they are needed (e.g. an opportunity is missing from the plans) and the same goes for the global planners. However, the interviewed regional planner says that adjustments are not done to ongoing months as most of the adjustments are needed in the mid or long term planning horizon. This might happen for example when the customer team has only forecasted for the upcoming 9 months, and has not updated the plan for the whole planning horizon, or when there is a need to give some visibility for the requirements coming from a new product. The adjustments made by the regional manager should not be a long term solution for the customer team planning, and the customer team is expected to update those adjustment in the next planning round.

The accuracy of a forecast is followed up at monthly basis. It is measured per customer team. The forecast accuracy is not just an indicator showing the planning quality, but it also affects the lead times and if needed, will be used as a guidance for possible product allocations. Normally in the customer contract there is an agreement of delivery lead time and this might be specified to differ whether the material was forecasted or not. If Company C is having problems in producing all of its orders, the **historical demand plan accuracy** is one of the **prioritization criteria.** These provide reasons for the customers to give accurate forecasts.

The accuracy of the forecasts has big variation between customer teams, which is partly due to differing business models. There are several functions to support the customer teams to improve their demand planning, whether the challenge is tool or process related. Best practices sharing and trainings are also organized when needed, either by the regional or global teams.

One critical factor is also the communication of the roles and responsibilities. **Communication of the impacts** of an accurate forecast helps in motivating the customer to develop its forecasting processes further. The support and understanding of demand planning importance at all levels is very important and will help in achieving better results, visibility and customer co-operation.

3.4. Benchmark D

3.4.1. Introduction to Company D

The benchmark Company D is a company in the food industry that operates in the Nordic countries and the Baltics. The interviewed person is a member of the core S&OP team, and has been involved in the S&OP process from the time it was started in the company. The S&OP process was started in 2013 as the management of the company named it as one of the most important **strategic business projects** of the company. S&OP had been discussed in the company already previously but it was not prioritized then. However now the S&OP process has been introduced organization-wide to the Company D.

The starting point for Company D and the challenge which they wanted to solve was the **harmonization** of the planning processes in the company. The goal of the S&OP process is to have a common global process that increases collaboration throughout the company and increases transparency between functions and business units.

As Company D operates in consumer business, it differs from the other benchmark companies and the case company. Its products are standard products which have quite a short lifecycle. The focus in the planning process is not to secure materials, as for many of the manufacturing companies, but instead to focus on the product portfolio to be able to answer the changing customer demand. One of the benefits that Company D has already received is the increase of transparency to its product portfolio and the success of new product introductions. This has been achieved by getting different functions of the company to cooperate better and share information.

The S&OP process was started in the lower level of the organization and the monthly reporting to the top management was introduced in April 2014. One of the main goals of the S&OP process of Company D is to help the company to reach its business targets and to be able to answer to the possible challenges proactively. The strategic plans are also used in the planning process by having them visible in the demand planning process.

The accuracy of the plans in Company D is measured in multiple ways. The actuals are compared to the plan made three months earlier and the bias is measured both on product level and in the total sales.

In the future Company D wishes to achieve a clear, common way of working throughout the organization. The S&OP process should have a clear structure and support the management needs. This culminates in the meetings, which should facilitate the formulation of a common view of the future and the fact-based decision making.

The biggest challenges in the S&OP process for company D at the moment include its insufficient planning tools, fragmented information and manual work. The people involved in the S&OP process in Company D have ambition to make good decisions based on knowledge and information, but the consolidation of information and development of good information systems often takes time.

3.4.2. Demand planning process in Company D

At the moment the S&OP process in Company D happens in three levels: global, business area (BA) and country. **Numerous parties** are involved in forming the plan, involving people from Marketing, Product Management, Financial Controlling and Sales. The inputs used in the planning process include a macro-market review; a list of key risks and opportunities that are not taken into account in the plan (basis for scenario analysis) and the strategic goals for the company.

The key account managers (KAMs) own the demand plan in Company D. The inputs are collected (mostly) from the key account managers on a country level, which are aggregated to the global business areas, where the BA managers review the plans. Later the BA managers will communicate the plans on the global group level. The time horizon for demand planning is eighteen months at the moment. This is due to the restrictions of the current planning tools, and the S&OP time horizon in the future will be three years. The focus will still stay in the first eighteen months, and the long term plans will be reviewed less frequently, probably on yearly basis. For the product review the time horizon is already three years. While KAMs own the plan of existing products, Marketing owns the plans of new products until the product launch.

Although there are **more than forty meetings** in the monthly S&OP cycle, these are one of the strong points for Company D. In the development of the process Company D has put a lot of effort in making the meetings useful and this can be seen in the results. The meetings are shortly reviewed after each one, and the participants find them really useful. They are seen as functional and valuable. The focus of the meetings is for them to be decision making meetings instead of just information sharing. If there is much information to be shared, an extra meeting with the meaning of information sharing can be arranged. In preparation for

the meetings in the S&OP process, required people fill out “one-pagers” that combine the information to be dealt with in the meeting. This lessens the need to go through the information during the meeting. Each meeting has a facilitator that distributes the information necessary for the meeting beforehand. The same facilitator also makes sure that during the meeting the **conversation stays in relevant topics. Each of the meetings also has clear (decision making) goals,** and the outputs of the meetings are also summarized in the previously mentioned **“one-pagers”**.

3.5. Benchmark E

3.5.1. Introduction to Company E

The benchmark Company E is a global company working in the healthcare industry. The interviewed person works with the continuous improvement team within supply chain. Thus the focus of this benchmark interview was more on the benefits and challenges for the department who utilizes the plan formed in the S&OP process. The products of Company E are mostly standard products, and although its customers can see their purchases as projects, the company considers its business more as volume business.

The S&OP process has been present in Company E for over ten years and the process has evolved during those years as the supply chain has become more global. The benefits that S&OP provides are mostly related to the **long term planning** and the **overall resource level.** Material planning in Company E is made mostly through the follow up of inventory levels.

The use of the plans is not always clear in Company E. Since there are some trust issues concerning the plans, the interviewee sees that the plans should not be seen as set in stone, but more as indicators of the future. In his opinion the production should be based on the real demand, instead of the demand plans. In his opinion the plans are utilized in a wrong way at the moment.

3.5.2. Demand planning process in Company E

The planning level for Company E is the product family level, from which the system disaggregates the plan top-down to the various products based on the historical shares. The plans are made on the regional level, which can be aggregated to the global figure. The time horizon for the plans is one year and the focus of the plans is usually in the next quarter.

The accuracy of the plans is **not measured systematically,** and there is **no clear responsibility** of the accuracy of the process. The S&OP team is responsible that the plan will be made, but they are not responsible for the plan accuracy, as they do not provide the information for the plans. In Company E the plans are made for revenue (in comparison to the other benchmark companies and the case company, where the plans are based on order intake). The inputs used for revenue planning are the booked orders and the tenders known by the sales.

As has been found, usually there are various functions involved in the S&OP process of an organization. This is the case also for Company E, which has in its S&OP process at least participants from Engineering, Marketing, Sales and the planning team.

Although according to the interviewee the S&OP process functions quite well, the input information is the challenge that decreases the trust in the plans. **More transparency** is needed to be able to trust the plans. While the process functions quite well, still some information from marketing can come straight to the factory level planning without the planning team being informed.

3.6. Summary of the findings from benchmark companies

The benchmark interviews confirm what was already found from the literature review: the S&OP process, and especially demand planning, can be **organized in various ways** in different companies. The reasons behind the need for a common planning process across the organization clearly affect the formulation of the planning process. As can be seen from the interviews conducted in the benchmark companies, for some companies the process has been implemented top-down (Company D) while for others the process has resulted from the need in the lower level of the organization, e.g. planning critical materials.

The benchmark interviews were mostly coherent with the findings from the literature review. Although some of the issues dealt with in the academic publications might not always be found in the business world, the issues dealt with in the practitioners' work are highly visible in the issues faced by the benchmark companies. For example the statistical forecasting was not present in most of the benchmark companies, even though in the academic literature it has been found beneficial in the forecasting and planning processes.

The key learnings from the benchmark companies can be seen in Table 5.

TABLE 5 KEY TAKEAWAYS FROM THE BENCHMARK COMPANIES

	Key learning 1	Key learning 2	Key learning 3
Company A	Importance of management support	Importance of trust on the distributed information	Importance of commitment of the Sales
Company B	Different planning process for volume and project business	Clear ownership of the plans	Continuous accuracy measurement
Company C	Strong management support	Clear ownership of the plans	Support for planning provided
Company D	Well- functioning meetings	Clear ownership of the plans	Continuous accuracy measurement
Company E	Importance of communicating the benefits		

The importance of **management support** and the **clear ownership** of the plans were topics that rose from many of the benchmark interviews. Also the different planning processes for different types of demand and the well-functioning processes were some of the key topics on which the benchmark companies provided more input. The benchmark interviews also confirmed what was found in the literature review: the **commitment** from Sales and **support** from top management is highly needed. The continuous accuracy measurements were also discussed in multiple benchmark interviews. They were found to help the continuous improvement of the outputs of the demand planning process. These findings will be discussed in more detail in the following sections. Even though the benchmark companies differ in some senses, they still share some of the same issues and challenges in their S&OP processes. This was the goal when choosing the benchmark companies: to find companies in various industries that deal with the same challenges in the planning processes as the case company.

3.6.1. Strategic planning and the role of top management

Need for the **support of top management** in the S&OP process was recognized in many of the benchmark interviews. In three out of the five benchmark interviews the support of top management as an important characteristic of a successful adaptation and use of the S&OP process was mentioned explicitly. In Company A the formal S&OP process had been suspended since the management did not see it as a priority any longer. On the other hand in Company D and Company C the top management commitment and support were showing as a positive reinforcement of the process. It was also found to facilitate the adoption of the process throughout the organization when it was clear to people involved in the process that the planning process is a priority. This was often led by the fact that the reasons and benefits of the S&OP process were communicated clearly.

In contrast, even though the top management was showing support for some of the benchmark companies, the **information flow** was still not always sufficient. In Companies A, B and C the S&OP plans are communicated to the management and the management provides feedback if the plans are not in line with the strategy of the company. The information flow to the other direction can be seen in Company D, where the company's strategic goals are visible in the demand planning system, making it easier to keep the strategic goals in mind while developing the plans.

However, as the goal of demand planning is to provide the most realistic view of the demand at a certain point, it might be good that the strategic goals are kept separate from the plans. This gives the possibility to do more thorough gap analysis and provides the possibility to see whether the strategic goals will be met or not. As was suggested by Mentzer & Moon (2004) the **difference between a forecast, a plan and a target** should be kept in mind.

Thus the relationship between top management and demand planning should include information flow from the planning to top management and vice versa. The importance of the S&OP and demand planning should be communicated clearly. Especially since the S&OP process is a cross-functional process including various stakeholders, the roles and responsibilities can often become less clear. Thus the **commitment of people** (starting from top management) is required. This was seen especially well in Company C that had managed to increase the importance of the planning in the company with the help of the management. If the challenging issues are raised all the way to top management level, the importance of the process becomes apparent to the various people contributing to the process.

3.6.2. Demand planning

The industry in which the company operates and its product characteristics have a large impact on the format of the S&OP process. While the companies in the manufacturing industry with B2B business are usually more concentrated on the material availability and factory capacity, the companies in the consumer business can have their focus more in the development of the product portfolio and answering the changing customer demand.

In most of the benchmark interviews the benefits of S&OP that were mentioned included the possibility to have a **better view of the future**, e.g. support for long term capacity planning and the development of the product portfolio. Materials that have longer lead times than the order delivery time pose challenges to the planning process and are one of the key reasons why a longer view and the planning process are needed in the first place. Other reasons include better communication to the suppliers to decrease the bullwhip effect and to develop more effective practices.

A clear benefit of a well-implemented S&OP process is the **better transparency** throughout the organization. A well-functioning demand planning process facilitates the **knowledge transfer** from Sales to Operations and Finance. This aids in creating the longer term plans and having a **one-set-of-plans policy in the company**. A common vision of the future is shared throughout the organization. As mentioned in many of the benchmark interviews, the

possibility to hear the comments behind the numbers provided by Sales also increased the trust in the plans on the Operations side.

The challenges faced in the demand planning are usually more related to the **content than the process**. Once the monthly meeting process had been established, in many of the benchmark companies the process was often working quite effectively.

The challenges faced by the benchmark companies were often related to the **commitment from the Sales.** The Operations' trust on the numbers provided by Sales was also often mentioned. This had led to the fact that in Company A the participation of Sales had been reduced to only providing the sales targets a few times a year. Since the Operations side could not trust the input coming from Sales, it was seen to not add any value. Company C has a different approach and it has tried to increase the accuracy of the forecasts and plans gotten from customers by introducing different lead times on orders depending on whether they were planned early enough or not. Different approaches can be taken to answer this challenge, but what became clear in the benchmark interviews was the fact that it is really important to get the Sales to take part in the demand planning process and to facilitate the process so that the forecast is trusted throughout the organization. The process of forecasting and getting commitment from Sales can be facilitated for example by introducing a CRM system as is being done in Company A. A common remark from the Sales is that their task is to sell, not to forecast or plan. Thus the forecasting process can often be seen as extra work. This can lead to the fact that it will not get done, if the importance and benefits are not communicated clearly enough. Facilitating the process can also improve the involvement and commitment of Sales to the demand planning process.

3.6.3. The process of creating the demand plan

The processes to create the plan varied a great deal already within the five benchmark companies. Although the planning systems might provide some kind of forecast based on the history, only one of the benchmark companies utilized this as an input for the plan. Only Company A bases its plans on history data and utilizes project information as an input to do judgmental adjustments. Three of the other benchmark companies used as the plan the inputs gotten from parties closer to their end users. Company B gets plans straight from its local sales offices, Company C gets plans from its customer teams, and Company D acquires plans from key account managers in its different business areas.

As other judgmental adjustments, Company D uses the **strategic goals** identified by the top management in addition to the **opportunities and threats** for the future that have not yet

been implemented in the plans. Company D also utilizes the **macroeconomic information** about its customer segments and **arising trends**. Companies B and C rely on the information acquired from **sales offices and customer teams** (respectively) to do their plan. In Companies B and C the core S&OP team rarely adjusts the forecast. On the other hand, product managers or business unit managers can adjust the plans on a global level based on the industry knowledge they possess. Regional demand managers can also adjust the plan in Company C, if e.g. last months of the planning horizon have not gotten enough attention and the plan is lacking. However, the goal is that customer teams will then do their own adjustments in the next S&OP round to give a more accurate plan than what was done previously by the region manager.

To compare with the literature review where the judgmental adjustments based on market, customer, project and product management information were identified, it can be seen that most of these are in use in various forms in the benchmark companies as well.

The **statistical forecast** suggested as a basis for the forecast in the literature review, on the other hand, does not seem to have as big of an impact that could have been estimated. The reason for this might be the differences in business environment: most of the case companies work in B2B, while statistical forecasting is often more used in retail business where quantities are higher and demand is more stae. As most of the benchmark companies get their plans mainly from people who are in contact with the customers, the customer information seems to be present in the forecasts. Market information is also often acquired from the people in the field, the sales people doing the ground work. Economic indicators were not often mentioned as inputs for the plans. However, according to the interviewees, they might be utilized when the Sales does their plan, e.g. the sales offices in Company B, the customer teams in Company C and key account managers of Company D might use these to formulate their plans which are then communicated to the S&OP process.

Utilization of the project information is in place in all of the benchmark companies, as various types of sales funnels are used and the most probable projects identified. Most of the companies also get information from product management that has industry specific information about their business lines. The combination of all the inputs results in a consensus demand plan.

3.6.4. Demand planning process and systems

A core team to facilitate the interaction between different functions is often needed in the S&OP process. In companies A, B, D and E a core S&OP team can be identified, which assists the collaboration across the organization. Also in Company C there are the region managers in charge of the plans made by the customer teams and the global managers in charge of the global plans. They also assist in the planning processes in lower levels. Various different systems were used in the benchmark companies and the utilized systems ranged from spreadsheets to complex systems and combinations of different tools.

While also the benchmark companies suggested that it is important to have the S&OP process first and the system to facilitate it after, which is in line with what the literature suggests, the manual work related to the not-so-sophisticated systems was mentioned as a challenge in the S&OP. But it was also mentioned that if the process had not been implemented first, the company would not have known what they actually require from the system.

The process of **gathering information** varies in the benchmark companies. In Companies B and C the plans are gotten from sales offices and customer teams, which the core team will then translate into a plan for the Operations. In Company A the core S&OP team has a meeting where it considers the history information and project information and forms a consensus plan. In Company D, however, the core of the demand planning process lies in the meetings. A lot of focus has been put in making the meetings useful. Participants know how to prepare for the meetings and information is prepared in a consistent way. Once the information is shared from various parties, a decision will be made.

These different processes demonstrate quite well the views that can be taken in the demand planning process. On one hand the demand can be divided into smaller parts that are planned separately (e.g. plans coming from each sales office/customer team), and though the demand is aggregated in to a higher level, it is not often changed in this level. On the other hand the demand can be planned on a more aggregated level, gathering inputs and indicators from various sources and developing and updating the plan on a higher level.

4. Synthesis of the literature review and benchmark companies

As discussed above, the S&OP processes and demand planning processes vary between companies. The different environments of companies, their different backgrounds, processes and key issues make it impossible to develop a demand and strategic planning framework that would work in all situations. Nevertheless, the key aspects of a functioning demand plan process can be identified. Based on the literature review and benchmarking interviews, key ingredients of a well-functioning demand plan are demonstrated in Figure 2.

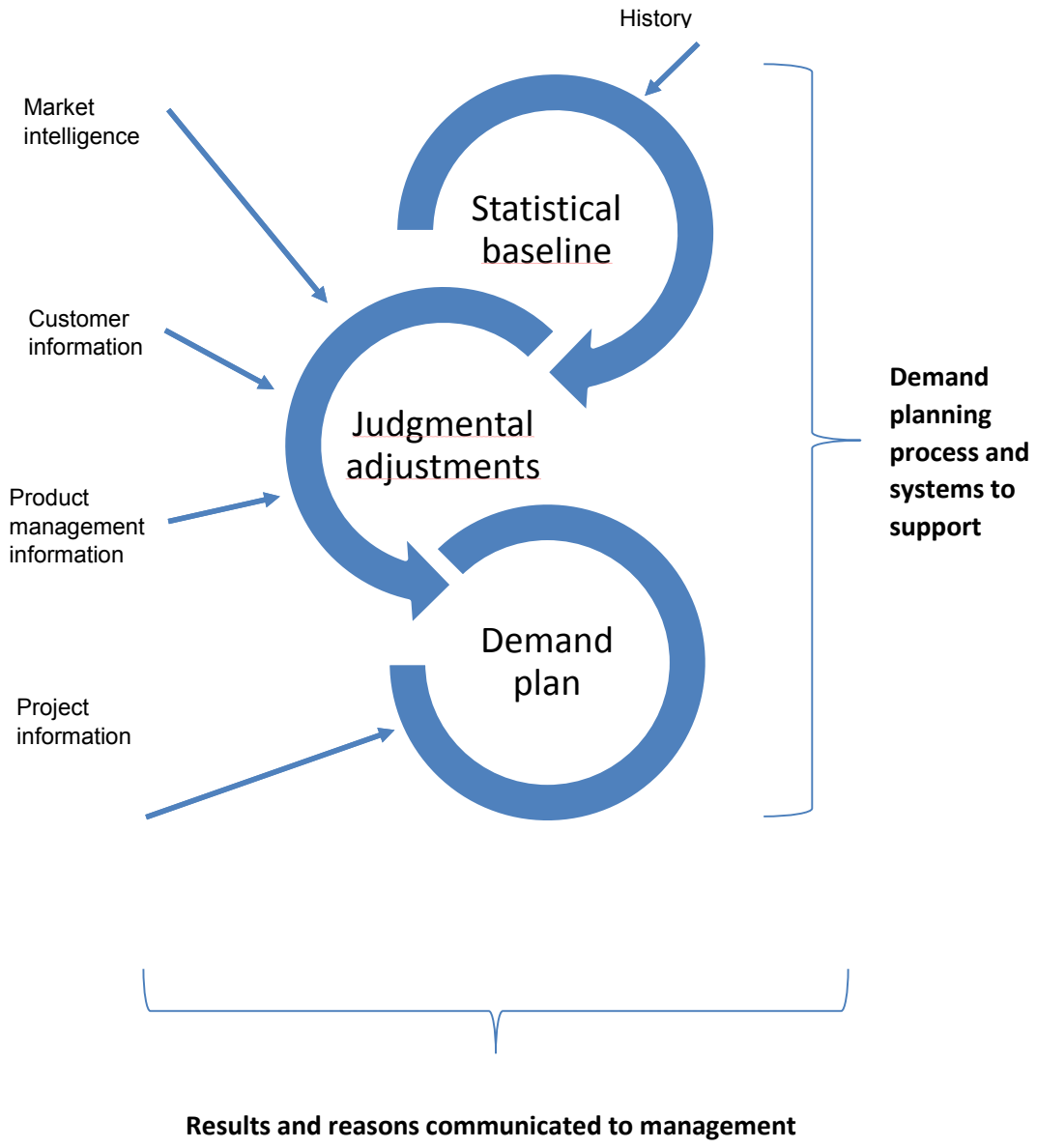

FIGURE 2 DEMAND PLANNING ELEMENTS

As was found in the literature review, **statistical forecasting** is often used to have a baseline forecast (Fildes et al. 2009). This can be developed with the use of various methods, e.g. time-series analysis or regression analysis (Mentzer & Moon 2005). Even though the statistical forecasting is often discussed in the academic literature, quite surprisingly it was not that popular in the benchmark companies and only one out of five companies utilized statistical forecasting in their demand planning process.

Judgmental adjustments are later added to enhance the statistical forecast. These often include information about the market, customers, projects and product roadmaps. The gathering of the information to base the judgmental adjustments on is often the phase of the demand planning process that varies greatly, depending on the environment a company is operating in. It is important to identify the information sources that provide the most relevant information for the company's demand planning. (Weigand et al. 2013; Sagar 2011; Eroglu & Knemeyer 2010) It should also be made sure that all the required information is acquired and utilized. While some companies are able to get forecasts directly from its customers, some companies have to rely more on the plans made by the Sales function. Depending on the type of business (volume vs. projects), sales funnels and probabilities can be a big factor in developing the demand plan. The role of the product roadmaps is greater when the product life-cycles are short, but in any case the product ramp ups and downs have to be carefully planned and thus have a big impact on the demand plan. (Phaal et al. 2004; Kappel 2001) Judgmental adjustments have a big impact in the planning process of the benchmark companies. Since statistical forecasting didn't have a big role in the demand planning process, most of the benchmark companies rely solely on the judgmental adjustments made to the plan by people possessing relevant information.

The process of **gathering all the relevant inputs** and combining them into a **consensus demand plan** can be challenging, and the demand planning process should be developed carefully to correspond to the characteristics of a company. The Operations side of S&OP requires a reliable demand plan to be able to optimize its processes well, and the S&OP is often only as good as the demand plan is. (Burrows III 2012)

The S&OP plan and thus the demand plan should be inputs for the management decision making in a company. The alignment of strategy and operations is one of the most important tasks of a company's management and S&OP is a powerful tool for it. Thus the management's needs should be taken into account when planning the process and on the other hand the **support from management** is an important factor to make the S&OP process function. The final S&OP plan also often needs the sign off from the management. Thus communicating

the relevant information in the right form can help both the demand planning and management decision making. (Alexander 2013)

As the S&OP and demand planning process is usually quite separated from the management and only the results and plans are communicated further, a functioning process that can be run independently should be formed. **Thus also the owner of the process should be clearly communicated**, e.g. who is responsible for the plan and its accuracy.

5. Analysis of case company

In this chapter analysis of the case company will be done. In the first section the case company and its operating environment will be presented. The second section will provide an overview of the challenges that the case company is currently facing concerning demand planning. The third section will introduce the demand planning process of the case company. Fourth, and final, section will provide a summary of the findings.

The information about the case company was acquired both in qualitative and quantitative form. The basis for this thesis was formed by semi-structured interviews that were conducted in the case company in the spring 2014. A total of 16 interviews was conducted in the case company. All of the interviews lasted from 45 to 90 minutes. People from various positions were interviewed, ranging from people from the factory operations to a person from the sales office of a European country. A summary of all the interviewees and their positions in the company can be found in Appendix 1.

In addition to the interviews, qualitative and quantitative information about the statistical forecasting possibilities in the company was acquired from an internal statistical forecasting study of the case company made in spring 2014. Quantitative information about the development of order intakes was also analyzed with the statistical analysis tool R. The program R in addition to MS Excel was used to analyze the correlations between various economic indicators and the order intakes of the company.

5.1. Introduction of the case company

The case company is a global corporation that is one of the largest engineering companies in the world. It operates in approximately 100 countries. One business unit (BU) of its five business units will be examined carefully and within that business unit two of its five product groups (PG) are the focus of the study. The goal is that the results found in these product groups can then be generalized to suit other product groups and business units as well. When the case company is mentioned in the following sections of this thesis, these two product groups within the chosen business unit are the ones being referred to.

These two product groups vary quite a lot when compared to each other. The product group 1 has more stable volumes and less project business. The business of product group 2 consists more of project business (~80%) and thus it has less stable demand. The order delivery times of product group 2 vary greatly, due to the fact that it is mostly project business. On the contrary, most of the order delivery times of product group 1 range from one day to some weeks. Both of the product groups have standard products in addition to products that are make-to-order (MTO), engineer-to-order (ETO) and configure-to-order (CTO).

The products of the case company are sold through various channels. It has key account customers that are handled separately; the products can be sold to local sales offices; and also straight to distributors. The case company has factories in 6 countries. While some products are made in multiple locations, some products are only made in one location. The planning process in the factory in Finland is the main focus of the thesis, but the planning processes in other factories are briefly mapped as well.

The reasons for the case company's need for S&OP and demand planning come mostly from the procurement department of the company. Some materials might have lead times of up to four to six months while the order delivery time of a product might be less than a week. In addition to good inventory control, good planning is essential to be able to avoid **material shortages.**

FIGURE 3 S&OP ROUND

The S&OP is organized in the case company according to Figure 3. Demand planning starts the monthly process of S&OP. Demand planning meeting gathers Sales and the core S&OP team, and during that meeting the demand plan for the upcoming 18 months is revised.

5.2. Current challenges of the S&OP process

5.2.1. Combination of the demand plans of various locations into a single global plan

There is a clear need to **combine the demand plans** of the case company's various factories around the globe. Some of the products forecasted to be sold in India can be ones that the factory in Finland has to produce and thus the **information flow** between the factories is important to be able to prepare for the upcoming demand.

The demand planning process of the case company was mapped focusing more on the process in the factory in Finland, but also examining the process in other factories in other countries. In addition to the interviews conducted, people involved in demand planning in other factories were contacted via email. It was found that the demand planning processes in different locations function differently. This is partly a result of the past processes and divisions of responsibilities.

Inclusion of people from various functions is typical for the S&OP and demand planning process. This can be seen also in the case company when examining the demand planning process of Finland and the other factories. For example people from Sales and Marketing, Operations, Supply Chain Management and Product Management were mentioned to have a say in the demand planning process.

Demand planning in Finland

Sales is responsible for the demand planning phase in the S&OP process in Finland. The inputs for making the demand plan are supposed to be gathered before the demand planning process of S&OP. The monthly process of S&OP starts officially with the demand planning meeting. Before the meeting the person/people responsible should gather the relevant information.

For product group 1 this means collecting the inputs from **regional managers**. The inputs are mostly gotten in qualitative form, stating if the business in a certain region is going up or down. Some estimations of the sales for the next quarters are also presented. Another input used is the views of **key customers**, which are gathered by key account managers. As a third input the **Purchase Manager Index (PMI)** is also collected as an economic indicator of the development of the market. These three are combined into an index, which could indicate the direction where the business is headed to. This index has not been in use for long, which

makes it hard to say yet if this indicator actually correlates with the order intake. The demand plans per product family are reviewed individually in the demand planning meeting.

In product group 2 this same index of regions, key customers and PMI is not in use. Since the business is more **project-based** in product group 2, the focus has been in developing a way to see the **changes in the quotation base**. As of now, the inputs for the demand plan include the forecast of demand divided to three key business areas. The development of the demand of these areas is used as an input for the demand plan. The newest PMIs are also reviewed, but not combined with other information into an index. The information about the changes in the project/quotation base, the market indicators and product management information about ramp ups and downs are then considered when the demand plans are reviewed. The changes to the demand plan are usually made in the aggregated level for the whole product group.

Demand planning in other locations

The inclusion of the product manager can be seen clearly in the demand planning processes in other locations. The **historical information** about order intake is the biggest driver for the future forecast and this is adjusted based on the **knowledge of the product managers** about **ramp ups and downs** or **incentive policies.** Forecasts from partners are limited and are received mostly when a big order is coming. **Economic indicators are** not utilized in the process. One of the comments from an S&OP team member in another factory was that the economic indicators lacked sense before.

At the moment the biggest challenges in the demand planning process in other locations according to the interviews include unexpected large orders and the forecasting/planning quality. These answers are more results of bad planning instead of the challenges that made the planning inaccurate. The underlying reasons why this happened were not mentioned in the interviews. The mention of unexpected large orders might be the result of a lack of communication between the sales offices and the factory. As challenges it was also mentioned that better **involvement from the Sales team** would be needed, and that a **standardized process** for workflows and decision making should be developed. Also the need to make the process more automatic and to introduce S&OP performance indicators were mentioned as things that should be developed.

The mentioned benefits of S&OP include a better understanding of the importance of demand planning and S&OP. The process is seen to function well in its monthly routine, and

the process helps in seeing the business **in the bigger picture**. The core benefit of an S&OP process was also mentioned: the ability to balance sales and operations.

Global management and its involvement in the S&OP process

The global product group management combines the heads of different teams, including Sales, Operations, Finance and Product Management. To define the relevant information for the global product group management team for the monthly reviews, five people from the global management team were interviewed. The people were chosen by being the ones who would be the ones providing the relevant information in the future. The interviewed people ranged from Operations and Sales to Finance and Product Management to be able to summarize a coherent picture of the needs. What was found is that there is a clear need for more information looking into the future. S&OP and also the longer term planning were found to be an important issue for the management.

The challenge is that while in the global monthly review meetings there are people from different functions presenting their views, the presentations are not always unified. If the S&OP presentation made for the local management team would be added to the global management teams agenda as it is, there would be overlapping information with other presentations in the monthly meeting. This will cause duplicate information, and result in inefficient meetings. The challenge is to combine the different sources of information to the same presentation so that there is only **one set of numbers** and plans for the company, and all the relevant information is still gathered.

In addition to global product group management there are also local product group management teams that approve the S&OP plans. At the moment the plans of monthly S&OP rounds are communicated to the local product group managements, but **the information flow** to and from the global management level is missing. Yet global management should have the best understanding about the markets as a whole. The sales target is present in the S&OP plans as a goal line to see whether the targets are reached or not. However, these are only visible for the ongoing calendar year and further vision of the **strategy and goals** of the case company is not visible in the S&OP process. Feedback to the S&OP team from the local product group managements is occasionally received if the S&OP plans do not align with the views of the management.

Based on the interviews conducted in the case company, the global product group management team was found to **focus more on the historical data** than the longer term plans, possibly because there has been no clear place where to find information of plans

aggregated to the global level. The global management team has not been involved in the S&OP planning process earlier.

A need to be able to see the plans for the future combined in the global level and a need to identify future trends and analyze the development of different industries became apparent from the interviews. Not only do the local and global management teams want to learn if there was a peak in the demand that was not planned, but the information why this happened is highly relevant, too. The **sources** where the demand came from and how could it have been foreseen better are **highly valuable information.** This is the kind of information that could possibly be available from the people closer to the customers, but is not yet available in a structured form for the management teams in different levels of the organization.

5.2.2. Internal challenges

The S&OP process has been ongoing in the case company for a few years now and the process has reached a phase of a good monthly routine. However, the focus in the planning tends to be quite **short-term** and most of the changes in the demand plans are made to the plans of next three months, although the planning horizon is 18 months.

The challenge in having a well-functioning S&OP process in the case company is the **complex environment** and the structure of the case company. Relevant information is stored in different places and the collaboration between different functions is not yet seamless. No sufficient information systems are available, which that would support the sharing of information.

According to the people involved in S&OP and demand planning, the demand planning process, and S&OP process in general, is **too manual**. This fact was mentioned in multiple interviews. Therefore it makes it difficult for the people doing the planning to focus on the exceptions in the data since the monthly process itself takes all the efforts available. Since there is a high number of different products in the company's planning portfolio, it is impossible to plan them individually. In the optimal case the standard products that do not have exceptions would go through the planning process with minimal effort, and the planners could focus on the exceptions that are causing bigger challenges. At the moment the process itself has been organized and implemented quite well and one of the Sales Managers mentioned in the interviews that now the process itself (based on the monthly meetings) functions quite well. More challenges are related to the content of inputs and outputs of the process than the organization of the process itself. At the moment the

implementation and development of an S&OP planning system is ongoing in the case company. This new system will in the future generate more challenges, e.g. a need for training, when the new process will be introduced to the company. Challenges related to this were also mentioned in the interviews.

Though the people from Sales can sometimes say that the S&OP process is additional work for them and their job should be to sell, they have also found benefits from the S&OP process. Sales people from both product groups said that doing demand planning as part of the S&OP process forces them to think of the future in a **more structured way**. Even though the task of forecasting and planning might be hard and might not be seen as beneficial as actual selling, it does implement a more structured way of planning for the future also in the Sales functions. However, as long as demand planning is seen as **additional work** that takes time from one's main responsibilities, it will not fully succeed.

Although S&OP and demand planning processes function quite well on a monthly basis as a process, the meetings themselves do not always function. Meetings with other factories sometimes result in nobody showing up or people showing up **unprepared.** The same can happen in the S&OP and demand planning meetings with the core team in Finland as well. This might be a result of the fact that the process is not totally understood and there is no common template or platform to show what information should be distributed. This results in big variations between meetings of different factories.

Even though the time horizon for demand planning is 18 months, the **focus** of the demand planning meetings is mostly in the **next one to six months**. A common comment from the interviews with the Sales people is the mention of a crystal ball and that the view of **the future becomes quite foggy** after three to four months. This struggle to forecast and plan for a longer time period is a clear challenge of the whole demand planning process.

To sum up the current situation about the general challenges in demand planning in the case company, the following can be said: The need for S&OP comes mostly from the procurement department. The long lead times of materials but short delivery times of the case company result in a need for planning. However, the complex operating environment of the case company, lacking information systems and the process that is too manual cause challenges to the planning process. In addition to this the process is not seen as a priority in Sales and the focus of the planning process is often more in the short term.

5.2.3. Information from various sources

The information that could benefit the demand planning process is **scattered** around the company. The information flow to the S&OP process and demand planning is insufficient, resulting partly from the **lack of support** of the information systems and partly from the culture of the company. The sharing of information is not always seen as beneficial. When a product manager from a sales office was interviewed, he commented on the topic by saying that only information about the biggest projects should be shared to the factory, other information is not valuable in his point of view. On the other hand, various reports are already required from the sales offices. The sales offices have to report monthly for example their forecasts of the sales for the next year on a product group level. Since the same sales office can sell products of various product groups and different product groups can require reports in different formats, this can be a lot of extra work for the sales offices.

The case company does not have a planning system that would support gathering all the relevant information and forming an informed opinion based on a structured use of different inputs. Instead, Sales have to collect the inputs in various ways and store them in numerous files, which makes the **process inefficient and time-consuming**. At the moment a planning system is being developed, which will hopefully provide possibilities to support the judgmental adjustments, for example by storing the historical indicators and providing a place where to collect various inputs.

When the Sales responsible for demand planning in product group 1 was interviewed, the lack of support from the systems became apparent. In addition to the demand planning process being too **manual**, the **lack of support** to provide different inputs for judgmental adjustments was mentioned. While now the inputs used include the PMI reports gathered monthly and the views of the key customers collected quarterly, the list of inputs that would be beneficial was longer. The inputs mentioned included:

- Information from the sales offices and the field
- known orders
- quotation base (projects) and hit rate of sales offices
- market intelligence indicators
- partner information

- channel information
- key customer information.

When interviewing the people in the demand planning process in product group 2, additions to the list above included

- knowledge from the product management and
- forecasts that sales offices do for the group level monthly.

The challenge with forecasts by sales offices is that they are not done on product family level as the demand planning, so at the moment they could more likely just give an indication on how the business is generally seen by people closer to the customer. The accuracy of the sales office forecasts is also not measured regularly, so it cannot be confirmed whether current sales office forecasts would be a good addition to the demand planning process.

The **market intelligence information** would also include examining to which segments the products have been sold historically. For product group 2 this can be done quite accurately, but the source data quality of product group 1 has caused some challenges. If the orders could be divided by segment, the market intelligence about various segments in different regions could be better utilized. At the moment this kind of data is not included in the process.

5.2.4. Summary of the challenges of demand planning

Challenges of the current demand planning process which were voiced in the interviews range from too manual process to the lack of commitment from Sales, the ownership of the plan and the various sources of possible information for the plan. A summary of the challenges related to the demand planning process explicitly mentioned in the interviews can be found in Table 6.

TABLE 6 CHALLENGES OF CURRENT DEMAND PLANNING PROCESS

Challenge	Comments	Comments
Process	Too manual	A planner needed to gather the information from different sources (and to analyze changes)
	Information should be gathered before the meeting	Preparation for the meetings
Ownership	Who owns the plan?	Who makes the final call?
Inputs used	Difficult to collect data	Important information from KAMs is the changes in demand, not the base load
	PM could be involved	How to get the information from the field?
	Knowledge from the quotation base?	History doesn't tell the future
Timeline	The sales have information about 3 months forward?	Focus shifts often to monthly even though it should be a longer time period – the big picture
	Sourcing needs information for longer time periods than the S&OP 15 months	
Accuracy	Accuracy measurement needed	What is the wanted accuracy?
	Not only the accuracy of a plan made in the previous month	Is accuracy of forecasts of sales offices measured?

As has been discussed in the earlier chapters, the challenges related to the demand planning process are related to the organization of the process, the ownership of the plans, the inputs utilized, the timeline of the plans and the accuracy measurement of plans.

When taking a higher level view on the challenges mentioned in the interviews, the challenges can be divided into three categories: the multiple possible sources of information, the alignment of plans, and the involvement of the global management team. These categories are summarized in Table 7.

TABLE 7 CHALLENGES RELATED TO THE COMPLEX PLANNING ENVIRONMENT

Challenge	Challenge in more detail
Multiple sources of information	*Information developed in multiple factories*
	Information about the sources of peaks in demand missing
Alignment of plans	*Need for longer term plans*
	All plans in the organizations should align – one set of numbers!
Global management team not involved in the S&OP process	*View of global management team missing*
	Relevant information for global management team needs to be mapped
	Future looking information needed
	Higher level comparison indicators missing
	Accuracy measurement needed

5.3. Current process of creating a demand plan

At the moment the demand plan in the case company is **updated monthly**. Statistical forecasts do not have a big role in the demand planning process currently, though they were briefly introduced into the process in autumn 2013. As a new planning system is now being implemented into the company, the statistical forecasting is planned to take a bigger role in the whole demand planning process.

Currently, in the demand plan meetings for product group 1, the demand plans are reviewed individually for each product family. The plans can be changed either on this level or on one level aggregated up or down. The adjustments to plans are often based on either a known project or the change in the buying behavior of one of the key account customers.

For product group 2 the changes to the demand plan are often made on the highest possible level, which is the total demand for the whole product group. The project information is often the basis for the changes to the demand plan.

The demand plan for each product group is updated in a monthly meeting that combines people from Sales and the core S&OP team. The inputs are supposed to be gathered before the meetings, though this is not always the case. No common process is in place of what the information that is supposed to be gathered is and where it should be stored. This has resulted in meetings having different kinds of forms depending on the information that has been gathered during the past month. This does not support a structured and organized way of gathering all the required inputs each month, which would be required to be able to analyze the source information and this way improve the accuracy of the demand plan.

After the demand planning meeting the plan is reviewed with the Operations and later communicated to the local product management. Adjustments to the demand plan can come in both of these phases too.

5.3.1. Analysis of the possibilities of statistical forecasting

Statistical forecasting is not used in the case company systematically. A statistical model was developed to see if the statistical forecasting could benefit the demand planning and increase the accuracy of the plans.

Since there are no formal planning tools that would support the creation of statistical models in use in the case company, a simple model was created in MS Office Excel. After trying a few simple statistical models (e.g. moving average, exponentially weighted moving average), the Adaptive Extended Exponential Smoothing (AEES) method, Holt-Winters, was chosen to be the most appropriate to forecast the company's demand. The choice was made based on the evaluation criteria of the smallest average percentage error. Holt-Winters proved out to have the smallest average percentage error, which was the success criteria for the developed forecasts. Based on Mentzer & Moon (2005), following formulas for level (L), trend (T), seasonal adjustment (SA) and forecast (F) were used:

$$L_t = \alpha * \left(\frac{S_T}{SA_{t-C}}\right) + (1-\alpha) * (L_{t-1} + T_{t-1})$$

$$T_t = \beta * (L_t - L_{t-1}) + (1-\beta) * T_{t-1}$$

$$SA = \gamma * \left(\frac{S_t}{L_t}\right) + (1-\gamma)(SA_{t-C})$$

$$F_{t+m} = (L + (T_t * m)) * SA_{t-C+m}$$

$$\alpha = \left|\frac{F_{t+1} - S_{t+1}}{S_{t+1}}\right|$$

L = *level* = horizontal sales level (what the sales would be without trend, seasonality or noise)

T = *trend* = the continuing pattern of a sales increase/decrease (can be a straight line or a curve)

SA = *seasonality* = a repeating pattern of sales increases/decreases that occur within a one-year period or less

S = *actual sales*

β = *beta* = smoothing factor for trend

γ = *gamma* = smoothing factor for seasonality

t = time period

C = period of seasonality

m = number of months between the forecast month and the last month with actual sales

Noise = random fluctuation that the model can't explain

α = *alpha* = smoothing factor for level that tells how much weight we want to put on last period's sales and how much for all the previous combined. (The more the level changes, the larger α should be to adjust quickly. The more random the data, the smaller α should be to dampen out the noise.)

Adaptive smoothing adjusts alpha continuously, which helps the challenge caused by not knowing whether the source of fluctuations is noise or changing level. Alpha (α) is the absolute value of the percent error from the previous period's forecast. The previous month's alpha can be used to adjust the value of α for the next period's forecast.

The optimal parameters for beta and gamma were calculated with the Excel Solver. The model seems to be able to adjust to the history of the product family quite well. Since the model was not in use with the case company for a longer period, the capabilities of the statistical model to adapt to the changes in the environment cannot be known. From this part of the study it could be seen that the statistical model was more accurate with **products that had a long stable history,** whereas **products with very intermittent history** could not be forecasted accurately.

This statistical forecasting was tried for product group 1 on a product family level. The forecasts were developed with the use of three years of historical data. The forecast based on the Holts-Winters method was then developed, based on the equations introduced earlier. The optimal values for beta and gamma were found using Excel Solver by mapping values that get the weighted mean percentage error (WMPE) as close to zero as possible. This simple statistical forecasting seemed to provide quite good estimates for some of the product families, while product families with more intermittent data or ramp up products were hard to forecast with these methods. Updating these forecasts was also an issue, since as every month there was a new data entry, the data parameters could have been updated and the forecast could change quite a bit. The limitations of Excel Solver also reduced the advantages of statistical forecasting, since the optimized parameters are not always the global optimums, but just the local ones. Thus the parameters obtained with the Excel Solver varied depending on the initial values and the attained forecast thus also varied with different parameters. Consequently the statistical forecast was found to be in need of a **human judgment** from a person who has information of the products and can thus use the **market** and **industry intelligence** to select the suitable parameters.

The statistical forecasting done in Excel resulted in both graphical and numerical demonstrations of the forecast. An example of the graphical view can be found in Figure 4

and the numerical demonstration in Appendix 2. The method picks up the patterns from the history and uses them to forecast the demand for the next months.

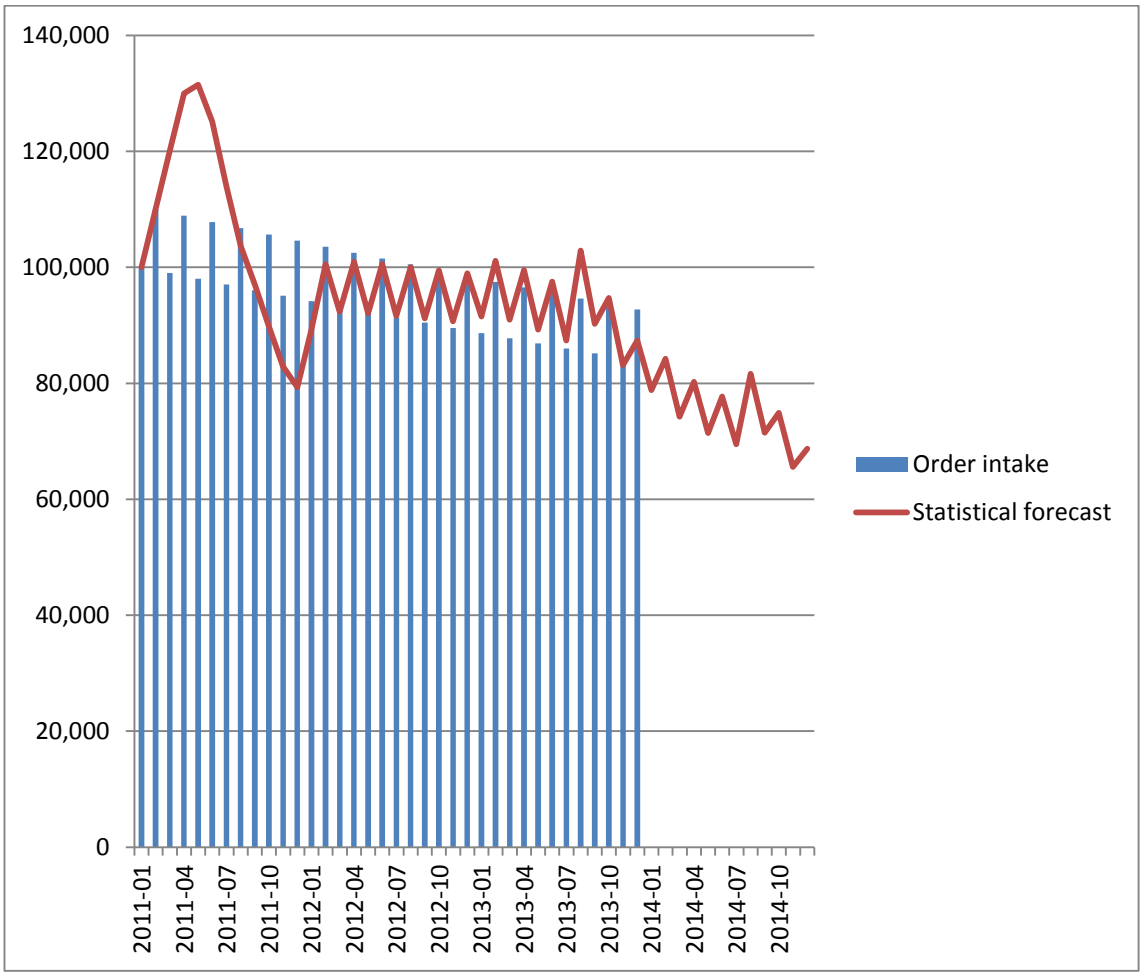

FIGURE 4 GRAPHICAL DEMONSTRATION OF STATISTICAL FORECASTING

In addition to these studies an internal statistical forecasting study was done in spring 2014 by a consulting company to review the possible advantages of statistical forecasting. One of the goals of that study was to find out what the best level to do the statistical forecasting is and how to aggregate and disaggregate the forecast to all required levels. The data utilized in the study was the historical order intakes of three example products from years 2010-2013. Two of them were from the product groups examined in this study and the third product was from a different business unit.

The results of that study indicate that while **statistical forecasting** as a baseline can benefit the demand planning process, it will not provide an easy answer that would solve the challenges related to demand planning. It could be implemented into the demand planning process as a new indicator that calculates the forecast based on history demand only. This forecast can then be reviewed in the demand planning meeting and used as an additional

indicator of the future. Although when aggregated to the product family level, the demand might seem quite stable, but a lot of the products within product families have very intermittent demand. This provides challenges and the weighted mean errors vary between the product families. A weighted mean error of about 10% can be achieved with some of the product families. Nevertheless, for other products the history is highly intermittent, and even the optimized statistical forecasts provide a weighted mean error up to 60%. The identification of these products is still an advantage for the company. Being able to identify the intermittent products will help in choosing the correct forecasting methods for different products.

Based on the statistical forecasting study it can be concluded that statistical baseline forecast to the demand plan would benefit the accuracy of demand planning in the company. The increased understanding of the level, trend and seasonality would also shape the thinking of the demand planners. This would help the analysis of historical information and thus also help to recognize the trends and seasonality of the future demand. But in order to get the full advantage from the statistical forecasting, **a competent person** is needed to analyze the source data and the resulting forecast. The forecasting process and its results should be comprehensible to the people making use of this data. If this is not the case, this could result in less commitment from the people involved in the process. Less commitment can easily result from a feeling of less responsibility if the statistical baseline forecast is trusted too much. This could move the mentality of the company towards relying on statistical forecasting too much instead of developing a fact-based plan. As one of the interviewed Sales representatives mentioned in the interviews, it should also be remembered that ***"History doesn't always explain the future".*** Thus the information available to a statistical model (i.e. the historical order intakes) is not enough to predict the future. For this we need additional information about the current situation of the company and its operating environment. This is the next step in the process and will be discussed in the next chapter.

5.3.2. Judgmental adjustments based on various information sources

Currently the demand planning process of the case company rests on judgmental adjustments. There is no statistical forecast that would indicate the trends of the business and thus all the adjustments made in the S&OP process are based on other factors. These factors include for example information from key accounts or sales offices about large orders,

reviews of the PMI index, plans for ramp up and ramp down products and the views of the operations.

The next sections will review current processes and possible inputs related to market intelligence, customer information, project information and information from product management.

Market intelligence as a better indicator of the future

At the moment the market intelligence included in the demand planning process is limited to the PMIs followed monthly. In addition to this, product group 2 follows the oil price regularly, but its effects do not often have an impact on the plan. It indicates the possible direction where the market is headed. The correlation of these indices to the actual orders has been reviewed once in the past, but this information is not updated or commonly known throughout the process. The correlations with the PMIs and order intakes were tested to some degree in the past, which resulted in a general feeling that the PMI correlates with the demand of product group 2 with a certain time lag. More comprehensive analysis on the correlations is needed.

Other than indicators of market development, the need of general market information surfaced from the interviews. The possibility to see for example news articles relating to certain industries in certain geographical areas was voiced as a good addition and source of information for the Sales. After an interview with the person in charge of market intelligence, it became apparent that this is already possible with the Market Intelligence portal in the case company. However, based on the interviews with the people from Sales, this possibility is not well known of.

Since the economic indicators that are used in the demand planning process at the moment are mostly just providing general feelings from the market instead of bringing concrete knowledge about possible market developments, the correlations between various indicators and the order intakes of the product groups are tested next. The correlation tests will provide better information about which are the most relevant indicators; do they actually correlate with the order intakes; and how big of a time lag is there until a change in the indicators is seen in the order intakes of the case company.

Order intakes from October 2009 until May 2014 were used to test the correlations of various indicators. Tests were made both on having monthly and quarterly figures. The quarterly figures were obtained by taking an average of the three months belonging to the quarter in

question. The order intakes were taken as totals for each product group and then divided into sub groups based on regions and product lines. Chosen indicators were mostly indicators that are already used in the demand planning process in the case company. Other indicators were also tested to see if they should be added in the process. The indicators tested were the Purchase Managers Index (PMI) for US, China, Europe and global, the OECD Leading Indicators for different areas and the Brent oil price. The chosen areas and their definitions can be seen in Appendix 3.

The indicator data was obtained from both the company's databases and the OECD web page. To get a comprehensive view of the possible relationship between the indicators and order volumes, the correlations were also tested with different lags. This was to see whether the case company's order intakes will for example have a certain time lag when following the business cycle indicators. Tests were made using the statistical analysis tool R and MS Excel.

Quarterly information was found to be a better indicator to use in the correlation tests, to eliminate the monthly spikes in the order intakes. On the other hand, the time lags between the indicators and actual orders were better visible in the monthly data. From the correlation results it could be found that while all the PMIs used in the process at the moment do not have very strong correlations to the order intake, relevant OECD Leading Indicators correlate strongly with the order data on the aggregated level and for certain product groups and families. The time lags between the correlations and orders varied depending on the indicator and the aggregation level of the orders.

As an example of the findings the summary of the findings of the global PMI can be found in Table 8.

TABLE 8 GLOBAL PMI CORRELATIONS

			LAG	0	1	2	3	4	5	6	7	8	9	10	11	12
Region	Product line	PG	Area													
All	All	PG1	Global	low	low	low	low	low	low	mid	mid	low	low	low		
All	Product line 1	PG1	Global	mid	high	high	mid	mid	mid	mid	mid	mid	low	low		
All	Product line 2	PG1	Global													
All	Product line 3	PG1	Global	low	low	low	low	low	low	low	low	low	low	low		
All	Product line 4	PG1	Global	low	low	low	low	low	low	low	mid	low	low	low		
All	Other	PG1	Global	mid	mid	mid	high	high	high	high	high	high	mid	mid		
All	All	PG2	Global	mid	mid	mid	low	low	low	low	low	low	low	low		
All	Product line 1	PG2	Global	high	high	mid	mid	mid	mid	low	low	low	low	low		
All	Product line 2	PG2	Global	mid	low	low	low	low	low	low	low	low	low	low		
All	Product line 3	PG2	Global	low	low	low	low	low	low	low	low	low	low	low		
All	Other	PG2	Global	low	low	low	low	low	low	low	low	low	low	low		

As can be seen from the Table 8, the global PMI doesn't seem to have that high of a correlation with the order intake of the case company. Correlation below 0.3 was considered as low, correlation between 0.3 and 0.65 as medium and correlation above 0.65 as high. A sample of the other correlation tables can be found from Appendix 4.

The main findings from the correlation tests include the **time lags** from which the best correlations could be found and the indicators that correlated most with the product groups and product lines. A clear finding from the correlation tests is that for product group 1 the highest correlations were mostly found with a lag of two quarters and for product group 2 with the lag of five quarters. The China PMI was found to be the indicator that correlates best with the order intakes of both product groups, even when the examined area didn't include China. With these tests the most relevant indicators were mapped for the case company to be included in the demand planning process.

Customer and distributor information

The information coming from **close to customers** is considered as a great way to see which way the business is developing in the short and midterm. This was found true in the interviews with people from Sales, and the information from the end customers was found to be especially important to predict peaks in demand. Currently the information coming from closest to the customers is acquired from the key customers and the region managers.

The difficulty in acquiring information from the sales offices comes from the fact that they serve various product group organizations. At the moment there is **no common way** of communicating the forecasts forward and there can be different product groups asking monthly forecasts in different formats with different templates. One common report for all the sales offices is the monthly reporting on product group level to the group, communicating the financial forecast for the next quarter and until the end of the year.

Based on the interview with the leader of key account managers, it can be said that **acquiring accurate forecasts** from the **key customers** is not easy. According to him, the time horizons for accurate planning vary a lot between the key accounts. Some have a stable business and the forecasts for next twelve months are easy to come up with, since the orders are already in the key customers' systems. But others have a more volatile business and have troubles giving accurate forecasts even for the next six months. In some cases forecasts can be quite accurate financially, but the products of the order can be changed until the last minute. In this case the forecast is of little use to the S&OP process since one of its biggest goals is to help the material planning.

According to the interviews, one reason for the challenges in collecting customer information is the fact that the case company has in the history (and still does) delivered the orders with short lead times when requested. **Why** would a customer provide a forecast of its future demand when they already know that they will get their order in two days also without

forecasting and there is **no extra incentives** to provide a forecast? As the forecasting process requires time and effort, most companies and sales offices do not want to do it unless it is required or if they get something out of the process.

The **motivation** to develop information for S&OP and demand planning within the case company and its customers is not on a high level. The motivation of most of the Sales people is low, since the benefits of S&OP are not seen. The demand planning process is seen as an **additional task** that needs to be done on top of the normal work. Since combining different inputs is also hard with the current tools and processes, the priority of demand planning can sometimes be seen as quite low. Especially the people further from the core S&OP team do not always see the reasons and benefits of demand planning.

Product management

Currently the product managers are not regularly involved in the demand planning processes of either product group. The information from product management is mostly utilized in the process of ramp ups or ramp downs of products. Based on the interviews it was found that the product management **should be involved in the demand planning process**. They possess for example industry specific information that can be utilized to explain the changes in the mix of products being sold. They also have the best knowledge about the plans for products being ramped up or down.

Information that product managers have is often for a **longer time horizon**. Product managers have information about the plans and goals for the product, but can be missing the information from the customers about events in the near future. As they have the view of the roadmaps and lifecycles of products, the plans are usually longer than the S&OP time horizon of 18 months. On the other hand, the need for plans that are for a longer time horizon became apparent in an interview with a sourcing manager. Especially with new products that are just being ramped up to production, the need for a plan of the final volumes of the product line are needed in order to be able to negotiate good contracts with the suppliers. At the moment this information cannot be found from one place and the information is updated irregularly.

Project information

At the moment there is **no system** to help plan the projects**.** In product group 1 the projects are not taken into account in the demand plan in a structured way, as only a small portion of the demand comes from projects. The demand plan is adjusted if there is information about a big order coming of a certain product, but this is done rarely. The information about the

projects is distributed via email or phone and not stored systematically. The adjustments to the demand plans are mostly inclusions of point loads to a short time period.

As a larger part of demand for product group 2 is coming from projects, they are planned in a more structured way. A table of projects and their possible probabilities is kept in order to adjust the demand plan accordingly. However, as the process is not embedded in the company processes, not all projects are on that list. Although product group 2 has a more structured way of planning projects compared to product group 1, the process has just been recently introduced in to the demand planning process and still requires improvement.

At the moment project information is more embedded as **one-time-loads** that come from a certain product family or a certain product within the product family. Adjustments to the demand plan are made according to the project information mostly if it changes the product mix within the product family. The project information should be taken into account more **systematically** in the planning process to be able to both analyze the past information and include the most probable projects into the demand plans.

5.4. Summary of findings from the case company's current situation

As can be seen already from analyzing two product groups within the case company, different characteristics of the business provide different requirements for the demand planning process. The overall **structure** of the process can remain the **same,** but the **inputs** used in the demand planning will and **should vary** depending on the business characteristics**.**

Key challenges in the demand planning process for both product groups include:

- the process that is too manual
- the identification of various possible inputs that could be used in the process but which are not systematically gathered
- the process of gathering relevant information, and
- the lack of commitment from the Sales.

A planning system is at the moment implemented in the case company to answer to the challenge of a too manual process, but the other challenges concerning the lack of commitment and the unidentified inputs still need to be solved.

The challenges in the demand planning in the case company are concluded in Table 9 on the next page.

TABLE 9 CURRENT CHALLENGES IN THE CASE COMPANY

Topic	Challenge	Challenge
General challenges	Plans for longer time horizon needed and should be stored in a common place	All plans should be aligned
	Need to be able to see the plans on global level	Correct information for the global product management needs to be mapped
	Future looking information needed for the global management team meetings	Reasons for peaks in demand should be identified
	Better involvement from Sales team needed	Standardized process for workflows needed
	Process is too manual, lacking information systems	S&OP performance indicators should be introduced
Judgmental adjustments		
Market intelligence	More detailed information about the correlations and time lags	Information about certain markets in certain countries needed
Customer and distributor information	Sales offices serve multiple product groups	No common way of working with sales offices
	Hard to get accurate forecasts from the key account customers	Forecasts and plans from key account customers vary greatly
	Low motivation from Sales	S&OP seen as additional work
Product Management	Currently product managers not involved regularly	PMs industry knowledge missing from the S&OP process
	Longer term plans already done, but by different people and without connection to S&OP	Ramp up plans kept in different locations, information hard to find
Project information	No system to facilitate planning and information storage	No structured way of planning projects into S&OP

While the S&OP process in the case company functions quite well on a monthly basis, more emphasis should be put on the content of the process. The **preparation for the meetings** is not done in a systematic and structured way and the **big picture** of how various sources of information connect to the actual demand should be attained. At the moment the success of the demand planning process is highly connected to the information from the Sales, which on the other hand does not always see the reasons and benefits of S&OP. Consequently, based on the interviews with the people from Sales, the reasons and more importantly, the benefits of S&OP need more communication throughout the organization.

6. Summary of the key findings

6.1. Key findings from the literature and benchmarking

Looking at the topics related to management decision making, S&OP and demand planning in the literature and in the benchmarking companies it can be said that **no one-size-fits-all process** can be identified**.** Even though the S&OP process in high level has the same main elements, **the implementation and characteristics differ** based on the company. This is probably one of the reasons to the fact that a lot of literature about the S&OP process comes from the practitioners' work.

Demand planning has many challenges and also **many stakeholders** in organizations. The required information to make an accurate demand plan often comes from various functions within the company as well as includes information from the market. One of the main challenges of demand planning is how to combine all of this information to make a consensus plan. Different stakeholders might have different motivations for planning, which can lead to conflicts of interests in the demand planning process.

Looking at the demand planning process, **two distinct parts** can be identified. First the **statistical forecasting process**, which can be either time series forecasting based on historical data or regression analysis based on outside indicators or other factors that have been found to have an impact in the demand. Second part is the **judgmental adjustments** made by the people in the demand planning process. These adjustments can be based on the information acquired from e.g. the market, customers, product management and projects. These can include information about point loads coming from key customers or projects or they can be seen as indicators of the general development of the market.

Based on the literature and benchmarks, one of the key aspects of a functioning S&OP and demand planning process is to have the management involvement and support for the process. Since S&OP is a tool of aligning plans in different time horizons and bringing strategy into the everyday operations of the company, top management involvement could have been thought to be evident. But based on the benchmark interviews this is not often true. The importance of the process should be recognized in order to justify the existence of the process.

6.2. Key findings from the case company

To answer the research questions from the case company's side, it can be concluded that **information sharing** is one of the key issues in order to develop an effective and fact-based demand planning process. The information flow that travels both ways, to and from the demand planning, will increase the visibility that the management has on the lower level information, e.g. what is happening in the sales office level. It will also provide answers to management's questions: why did this spike of demand go unnoticed?

At the moment the information from demand planning and S&OP does not flow to global management's monthly meetings, which should be improved. This can be quite easily facilitated by creating a monthly report that **summarizes the key information** required by the management. The first versions of this report have already been developed in cooperation with the management team, and the development will continue.

Taking a look at the demand planning process in the case company, the main challenge is the **lack of information** to support the planning. While various sources of information exist around the organization, the information is hard to combine to be in a single place. Looking for the information takes time from the Sales responsible for the demand planning. This has led to the use of only few indicators in the demand planning process. Even these indicators are just being introduced into the process and the correlation to for example the order intake has not been tested in a comprehensive way. The correlation tests made in this study provide proof that for example certain PMI indices and OECD Leading Indicators correlate quite well with the orders of the two product groups with various time lags. Acquiring more accurate customer data for the case company is now being improved by creating a case company specific customer index questionnaire for various sales offices and key customers.

At the moment the demand planning process depends on the **judgmental adjustments** and no statistical forecasting has been utilized in a structured way in the planning process. In the course of this thesis in addition to the statistical forecasting studies presented in the thesis, also an internal statistical forecasting study has been made. **Statistical forecasting** was proven to be able to forecast the future demand quite well and will be implemented in the demand planning process in the future.

Based on these key findings, the suggested demand planning process is presented in the next chapter. It would answer to the key challenges to get more fact-based decisions: lacking information flow, lack of commitment from Sales and the role of different indicators.

7. Suggested improvements

To answer the challenges presented in the previous chapter, some improvement ideas are presented in the following sections. The chapter will first introduce general improvements to the case company's demand planning, and then continue with two distinct solutions of how to organize the demand planning process.

7.1. Identifying the possible general improvements

7.1.1. Improving the demand planning process

Even though the reasons and benefits of S&OP are quite clear to most of the people interviewed, it became apparent (especially in the interviews with people from Sales functions) that **the reasons should be communicated more** around the whole company to gain **wider acceptance** for the process. This would also facilitate the sharing of information from different functions and the development of a consensus plan. As there is only a couple of people from the Sales department involved in the S&OP process, this mindset of planning in a more structured way and the benefits of planning should be spread further through the Sales organization.

The information flow from the demand planning team to multiple directions should be increased to make sure that all the relevant people have the most accurate information needed. The goal in the future is to have the global plans available and communicated monthly to the global product group management, so that they can be compared against for example the company strategy and thus gap analysis can be performed. A process to reach this goal has been started during the time of this thesis.

As the demand planning process was seen too manual in the interviews, the next step is to **improve the systems** that support the process. Thus more efforts could be used in the actual planning and the focus could be more in the exceptions and important cases. One way to make the meetings more efficient and structured could be introducing one-pager templates, as seen in one of the benchmark companies earlier. A meeting could be facilitated with a template of the information that needs to be gathered before the meeting. This would make the process easier as the needed information would be in an explicit form instead of just communicated via talking during the meeting. Formalizing the process more (without making it too bureaucratic) would help in communicating the reasons and expected outcomes of the meetings.

Various people from different functions mentioned in the interviews that the **accuracy** of the forecasts is also a clear issue. This is also something that the management teams want to improve. The need to measure forecast accuracy in a more organized way and the possibility to see the accuracy in different levels, e.g. global, per factory or per product line became clear from the interviews. The structured measuring of the accuracy could then result in better accuracy levels overall. A target level for the accuracy also needs to be developed, thus setting a good-enough level for the accuracy considering the business the case company is operating in. After considering various accuracy measurements, the easily understandable mean percentage error (MPE) is chosen to be the accuracy measurement to be followed monthly. The idea behind the accuracy measurement is to have the summary of accuracy presented in the monthly management meetings, and the cases with low accuracy to be reviewed systematically. In the beginning the plans will probably not be the most accurate, but as the process evolves and the reasons behind the bad accuracy are analyzed, the demand planning process should start yielding better results.

In addition to the plans and forecasts within the S&OP time horizon, which for the case company is 18 months, there are for example longer term plans elsewhere in the organization to communicate product roadmaps. There is also a long term strategy for the next five years. A challenge is to make sure that these **plans align and** that all of the **plans are up-to-date.** A need from the Sourcing and Purchasing departments has risen to have longer term plans for different products easily available in one place, up-to-date and combined with the S&OP plans to be able to negotiate contracts with suppliers for the materials especially for the ramp up products. To address this problem, a view of the demand plans for different time horizons was developed as one of the deliverables of this thesis. This process is at the moment being implemented to the case company. In addition to the S&OP plans, a longer time horizon plan will be developed for all the products, with special focus on the change cases. The focus of the S&OP process will be in the first 18 months, but the longer term plans will also be checked regularly, with most interest on ramp up and ramp down products. Introducing the **longer term plan** to the planning processes will improve the alignment of different plans. It will also increase transparency, since everybody knows where the information about plans can be found. This will facilitate especially the work of the sourcing and purchasing managers.

This definition of planning horizons can be seen in Figure 5.

Process	Order Delivery Process	Sales and Operations Planning (S&OP)	Long term planning	Strategic planning
Timeline	Short: Daily/ Weekly	Mid: 0-3 months (capacity) 4-18 months (materials)	Long: 1,5-3 years	Strategic: 3-5 years
Owner	Operations	Sales	Product Management	Product group management
Inputs	• Known orders *Process of scheduling instead of planning*	• Local Sales Office forecasts • Market information • Sales history data • CQP for project business • Long term plan	• Based on the S&OP plan • Product portfolio development • Sales history data • PG strategy	• Business unit/ Product group strategy
Reference		Sales budget	Strategy	
Review time	Daily	Monthly	Quarterly	Yearly
Level	• SKU	• Product family + region • Region	• Product line • Product family	• Total (global + regions) • Product family • Product line • Area development

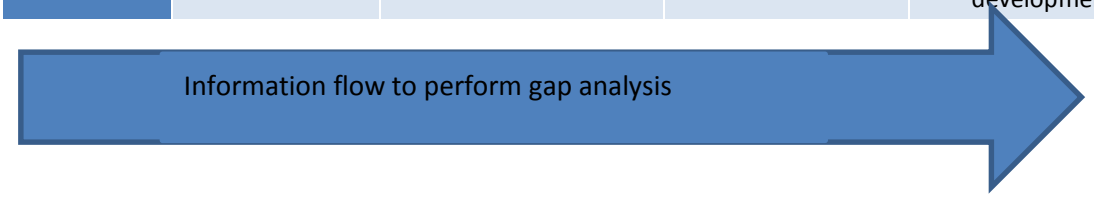

FIGURE 5 DEFINITION OF PLANNING HORIZONS

7.1.2. Improving the demand planning inputs

One of the biggest issues of demand planning in the case company is the **lack of commitment** from Sales. Also the fact that demand planning and S&OP is seen as more of an additional task on top of the normal workload does not help the process. This could probably be improved by communicating the advantages of demand planning better, which would hopefully lead to a change in the attitudes and mindsets.

On the other hand, to support the **inclusion of projects** in the demand planning, a system storing the information relevant for the projects (details, probabilities, average hit rate etc.)

would be necessary. This is developed in the case company at the moment and should help the planning of projects in the future.

Product management will also be taken into the S&OP process on a regular basis. For product group 1 the plan is to have representatives of the Product Management in the monthly demand planning meetings. Since there are four product lines in product group 1, the product managers will participate in the meetings on a circulating basis, so each one of the product managers is present in the meetings three or four times a year. Having one of the product managers present in the demand plan meetings will create regularity in the process. Since there are not that often changes in the longer horizon plans, reviewing the product lines once per quarter is predicted to be frequent enough.

As can be seen from the analysis in the previous chapter, various indicators of **market intelligence** should be included in the demand planning process as they were found to correlate strongly with the order intakes of these two product groups on various levels.

7.1.3. Summary of general improvements

The general improvements for the case company were discussed in the previous sections. These are summarized in Table 10.

TABLE 10 SUMMARY OF THE GENERAL IMPROVEMENTS SUGGESTED FOR THE CASE COMPANY

Challenge	Improvement 1	Improvement 2
Information developed in multiple factories	Development of templates for needed information	Information storage
Information about sources of demand missing	Information flow from Sales	Information storage
All plans in the organization should align	Planning horizons	Longer view (quarterly) to demand plan
Need for longer term plans	Planning horizons	Longer view (quarterly) to demand plan
Global product management team not involved in the process	S&OP slide set to the global management team meeting developed	
Need of relevant information for the global management team	S&OP slide set to the global management team meeting developed	
Future looking information needed	S&OP slide set to the global management team meeting developed	
Accuracy needs to be improved	Accuracy measurement system developed	Accuracy measurement as one part in the global management slide set
Sales targets(/other higher level view of the future) only available for the ongoing year	Possibility for longer term indicators discussed with Product Management	

To conclude, in general the case company needs **a more systematic and structured way of planning**. The information utilized in the demand planning process as well as the information developed in the demand planning process should be stored and analyzed. The summaries of this information should also be communicated higher to the management on a monthly basis. The continuous analysis, measuring and improvement of the demand planning process should lead to higher accuracy in the demand plans and thus better information will be distributed to all parties.

7.2. Possible solutions

When considering the main findings of the previous chapter, i.e. the challenges and characteristics of the case company, two ways of answering these challenges where developed.

Evaluation of the case company's current situation and challenges led to the identification of two possible directions in which to develop its demand planning process. The first one has its roots more on the benchmark interviews, whereas the second one is a synthesis of both the literature review, the benchmark interviews and the interviews inside the case company. Both of these solutions help answer the challenges identified in the case company's demand planning process.

- The first direction would include identifying the sources of demand clearly for the case company and give responsibility to the parties closer to customers to provide plans and forecasts. Thus the demand plan would be combined from sub-plans collected from those sources.

- The second direction is to introduce statistical forecasting as a fact-based indicator and then develop ways to include judgmental adjustments into the demand planning process based on additional information gathered in a structured way.

These two directions will be discussed in more detail in the following two sub chapters.

7.2.1. Solution 1: Combining the demand plan from various sources

The first solution is based mostly on the benchmark interviews. It would include identifying the best feasible point close to the customer where information of the future demand could be acquired. As can be seen from the benchmark interviews, for Company B it was the sales offices, whereas for Company C it was the customer business teams. This approach would work for the volume business, while the big projects should still be planned separately. Information about them should be acquired from the Sales people responsible for these projects as was done in Company B.

This solution would introduce responsibility of the planning closer to the sources of demand, e.g. the sales offices and key account managers of the case company. The core S&OP team

in the factory organization would then combine these plans into the overall plan to be reviewed by the product group management.

A simplified demand plan coming from this solution is presented in Figure 6. It shows that a part of the demand comes from Key account 1, another part from Sales Office 1, and so forward.

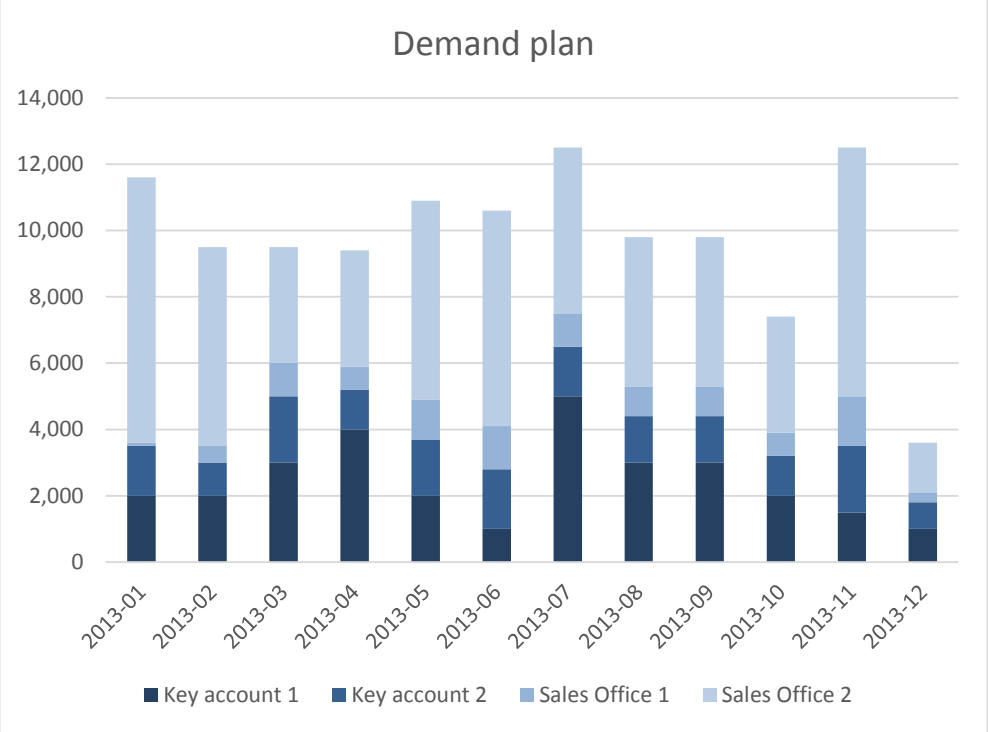

FIGURE 6 DEMAND PLANNING – SOLUTION 1

If the case company chooses to take this approach, the next steps should include **identifying the possible sources of demand** for the factories and finding the accurate information to get the future plans of these sources. These might include for example the plans the sales offices have to make for the top management monthly, the plans of key customers and the project plans from the responsible Sales people. It should be examined if this information is already available and then the accuracy of this information should be analyzed. If this information is available and accurate enough, the update frequency of this information should also be examined.

Since a common challenge in the case company is that sales offices and departments have to fill in various reports a month, it is possible that information needed is already available or that existing reports could be developed to support the demand planning in addition to their original reason. But even if the information could be acquired from a report or a system, the

ownership of the information should be defined. In order to get good quality inputs for the demand planning process, there needs to be **people responsible** for the input data quality.

The challenges in implementing this solution to the case company come from the complex environment that it operates in and the fact that this is not a process that is already in use in the company. Acquiring accurate forecasts and plans from sales offices and key accounts can prove to be a great challenge and at the moment the information systems of the case company do not support this solution. As the case company has over 100 sales offices and various key accounts, the implementation of this solution will probably be challenging and take time. In addition to developing an information system that would support this solution, the attitudes of people need to be changed. As sharing plans and forecasts from the sales offices is not a current process and can be seen as useless, the implementation would require great efforts in demonstrating that this would actually benefit the company as a whole as well as the people involved.

Table 11 shows how this solution answers the challenges in the case company's demand planning process that were identified in the previous chapter.

TABLE 11 HOW SOLUTION 1 ANSWERS TO CHALLENGES IN DEMAND PLANNING IN THE CASE COMPANY

Topic	Challenge	Challenge	Answer
Strategic planning	Plans for longer time horizon needed and should be stored in a common place	All plans should be aligned	Planning horizons defined and implemented
	Need to be able to see the plans on global level	Correct information for the global product management needs to be mapped	S&OP information shared monthly with global product management in a relevant form
	Future looking information needed for the global management team meetings	Reasons for peaks in demand should be identified	Focus not on the past events but both on the future plans and the reasons behind the past events
Demand planning process	Better involvement from Sales team needed	Standardized process for workflows needed	People from the sales offices and key account managers trained to be in the S&OP process: **division of responsibility**
	Process is too manual, lacking information systems	S&OP performance indicators should be introduced	S&OP process supported by a planning system, workflows and responsibilities defined

Judgmental adjustments			
Market intelligence	More detailed information about the correlations and time lags	Information about certain markets in certain countries needed	People in sales offices and core S&OP team educated to use market intelligence: best practices shared
Customer and distributor information	Sales offices serve multiple product groups	No common way of working with sales offices	**More responsibility to sales offices about the accuracy of plans: incentives and accountability**
	Hard to get accurate forecasts from the key account customers	Forecasts and plans from key account customers vary greatly	**Incentives** for key account customers developed - more close cooperation to get the plan
	Low motivation from Sales	S&OP seen as additional work	Benefits of S&OP communicated more thoroughly
Product Management	Currently product managers not involved regularly	PMs industry knowledge missing from the S&OP process	Product managers involved in the S&OP process
	Longer term plans already done, but by different people and without connection to S&OP	Ramp up plans kept in different locations, information hard to find	All plans kept in the same place and checked to be aligned
Project information	No system to facilitate planning and information storage	No structured way of planning projects into S&OP	Common Quotation Platform (CQP) or another system to facilitate the planning of projects

As can be seen, the accuracy of planning in this solution depends greatly on the ability of the Sales offices to plan and forecast into the future.

The process of taking this solution into use would include:

1. Identifying the sources of demand (dividing the historical demand into pieces so that all of the pieces have a source and a person responsible)
2. Identifying the level of planning required (by the Operations)
3. Developing an information system that would support the sharing of information from various sources

4. Appointing a person in the factory level in charge of the demand side of S&OP who is responsible for that all of these sources would develop plans monthly in the future

5. Communicating and training so that all the people responsible for their fraction of demand know why they are forecasting and planning the demand and how should they communicate it further

6. Continuous measuring of the accuracy of the plans – possibility to identify best cases and the ones struggling with forming the plan

7.2.2. Solution 2: Statistical forecasting as a baseline forecast and development of the process to acquire judgmental adjustments of better quality

The second solution is a combination from the solutions provided in the literature and various aspects from the benchmark interviews.

As the case company operates in a complex environment and the demand is coming from dozens of sources, it might be difficult to implement a process where the demand plans from each of these demand sources are acquired in an accurate-enough way. The second solution takes this into account and is formulated in a different way.

Statistical forecasting would be viewed as the baseline forecast of the future demand. This would be developed with a time series method, with historical data of good quality. Statistical forecasting helps in dealing with the large number of stock keeping units (SKU), taking away the need for planners to evaluate a plan for each SKU individually. The statistical baseline would be enhanced with the **judgmental adjustments** coming from different sources. This would result in an intelligent plan instead of a static statistical forecast. These judgmental adjustments could for example include the sales managers, key account managers and product managers and their views of the future.

To be able to implement this solution, the company needs to **identify the sources of information** that are relevant to planning its demand. These sources should be the ones that the statistical baseline cannot forecast based on the history. These sources might include information from the market, customers, projects or product roadmaps. The **market intelligence** might for example include the growth of market size in various regions and decline in others. The **customer information** could include the increased demand from a key customer because of a better contract. **Project information** includes for example the

information of a project that has been negotiated for a long time period and is approaching the purchase order phase. Information from **product management** could include the knowledge about upcoming product ramp ups and ramp downs and other industry specific knowledge. In addition to detailed changes and point loads, all of the sources mentioned above could be considered as indicators of the market situations. The overall "feeling" of different sales areas could be gathered monthly to form a case company specific customer index that would demonstrate the current market situation. The changes in plans of key customers could also be seen as market indicators, since the key customers are often also the big customers that feel the market changes. The increase or decline in ongoing quotations could also be seen as an indicator of the current market situation.

Figure 7 shows an example of the demand plan that could be developed with the use of this approach. It shows that the actuals are divided into different sources, but the plan for the future is seen as the total in general. In the planning view also the statistical forecast can be seen as a "benchmark" for the demand plan. The demand plan can also be changed in a lower level, which will then have an impact on the total level as well.

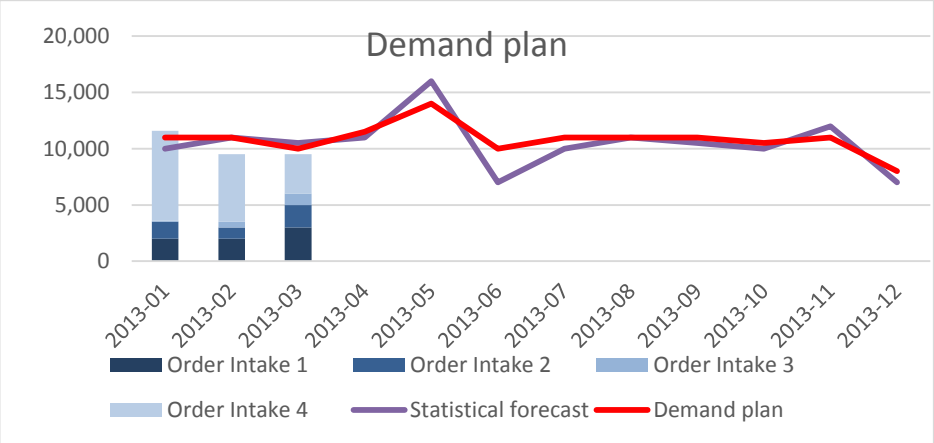

FIGURE 7 DEMAND PLANNING – SOLUTION 2

As can be seen from previous analysis, there are **various possible indicators** to use if Solution 2 is chosen. The challenge comes from defining the relevant indicators and identifying the relationships they have with the demand of the case company. This can be done by examining the historical information and checking the correlation between the indicators and the demand. But since all of these possible indicators are not followed in a structured way yet, the examination of the possible indicators is not feasible yet. As a result, the possible indicators should be identified and the data should be collected for a certain time period, so the correlations and time lags could be examined.

Based on this study, the most relevant indicators for both product groups were identified, including the time lags between the indicators and the order intakes. To make sure that the indicators are reviewed often enough, this solution would include updating the correlation analysis quarterly (since quarterly information was used). This should be done by the demand planner/business analyst and then be communicated forwards to the people in the S&OP process. The continuous following of the most relevant business indicators should result in developing the mindsets of the people involved in the planning, and thus result in more accurate and more fact-based plans.

Table 12 summarizes how Solution 2 answers the challenges presented in the previous chapter.

TABLE 12 HOW SOLUTION 2 ANSWERS TO CHALLENGES IN DEMAND PLANNING IN THE CASE COMPANY

Topic	Challenge	Challenge	Answer
Strategic planning	Plans for longer time horizon needed and should be stored in a common place	All plans should be aligned	Planning horizons defined and implemented
	Need to be able to see the plans on global level	Correct information for the global product management needs to be mapped	S&OP information shared monthly with global product management in a relevant form
	Future looking information needed for the global management team meetings	Reasons for peaks in demand should be identified	**Focus not on the past events but both on the future plans and the reasons behind the past events**
Demand planning process	Better involvement from Sales team needed	Standardized process for workflows needed	People from the sales offices and key accounts educated about the benefits of S&OP. Communication of benefits of S&OP communicated to Sales. **Demand planner/business analyst to be appointed.**
	Process is too manual, lacking information systems	S&OP performance indicators should be introduced	S&OP process supported by a planning system, workflows and responsibilities defined

Judgmental adjustments			
Market intelligence	More detailed information about the correlations and time lags	Information about certain markets in certain countries needed	Market intelligence portal more in use and market indicators' correlations with the order intake tested
Customer and distributor information	Sales offices serve multiple product groups	No common way of working with sales offices	**A process of acquiring information from sales offices developed**
	Hard to get accurate forecasts from the key account customers	Forecasts and plans from key account customers vary greatly	**Incentives for key account customers developed** - cooperation to get accurate plans
	Low motivation from Sales	S&OP seen as additional work	**Benefits of S&OP communicated more thoroughly throughout the Sales**
Product Management	Currently product managers not involved regularly	PMs industry knowledge missing from the S&OP process	Product managers involved in the S&OP process
	Longer term plans already done, but by different people and without connection to S&OP	Ramp up plans kept in different locations, information hard to find	All plans kept in the same place and checked to be aligned
Project information	No system to facilitate planning and information storage	No structured way of planning projects into S&OP	Common Quotation Platform (CQP) or another system to facilitate the planning of projects

As can be seen from Table 12 above, the success of this solution depends greatly on the development of the process of how to acquire information from multiple sources and have a competent person or team to combine all this information into a fact-based plan.

The implementation of this solution would include the following steps:

1. Developing the statistical forecasting system and defining the accurate planning level
2. Identifying the best sources of judgmental adjustments
3. Gathering data about the relevant indicators

4. Checking the correlations between the historical data and the indicators
5. Choosing the most relevant indicators
6. Developing the planning system to support the inclusion of these indicators into the process
7. Appointing a person to the planning team who would be in charge of gathering and analyzing the new inputs
8. Educating people about the indicators and the new process
9. Measuring accuracy of the demand plans and the explanatory value of the indicators

In addition to the indicators of the direction of where the business is going, also information about single point loads would be included into the demand plans. These could include for example changes in the product mix or knowledge about upcoming big orders that can't be forecasted from the history.

The possible sources of judgmental adjustments would include amongst others:

1. Market feeling gathered from the Sales people in the field
    a. Short questionnaire for a selected sample of sales people monthly
    b. Questionnaire for the region managers
    c. Change in the plans coming from the sales offices to the group
    d. Change in the plans coming from the key customers
    e. Feeling from the distributors
2. Macroeconomic market indicators
    a. PMIs
    b. OECD Leading Indicators
    c. Brent oil price
3. Industry specific indicators
    a. Oil price
    b. Sales of motors

4. Market development gathered from the project point of view
    a. Change in the quotation base

A key factor in a successful implementation of Solution 2 is to **identify the most relevant indicators** of the business. To be able to identify the indicators that explain the changes in the business the best, the historical data of the indicators should also be analyzed. This solution would also include storing the information gotten from the indicators, so their explanatory value could be explained in hindsight.

A challenge in implementing this solution is the gathering process of the indicators. At the moment the planning systems of the case company do not support storing and sharing information in an easy way. The relevancy of various indicators and inputs should be examined more (e.g. possible forecasts from sales offices, project quotation base information, hit rates) to have a comprehensive view of how all the pieces fit together.

7.2.3. Comparison of Solution 1 and Solution 2

The main difference in these two solutions is that in Solution 1 the demand is divided into sources and planned separately by various people, while in Solution 2 the statistical forecasting would provide a reference for the total demand, and people responsible for various sources could then make their changes to the plans based on the information that they have.

A summary of the two possible suggestions can be seen in Figure 8 on the next page.

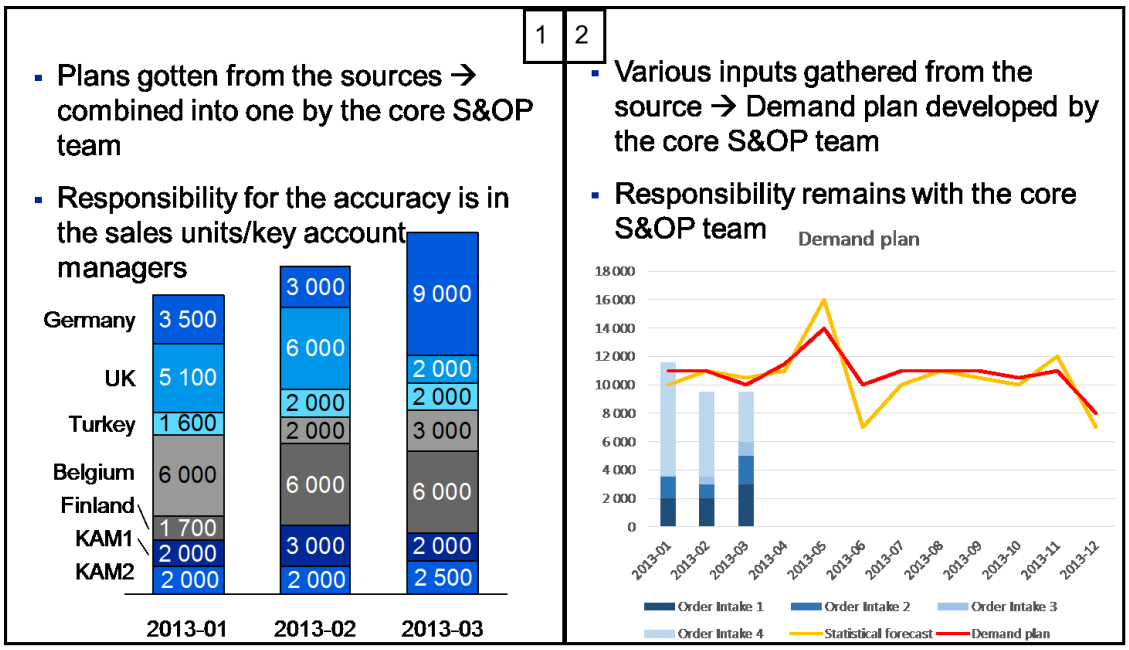

FIGURE 8 COMPARISON OF POSSIBLE PLANNING APPROACHES

Solution 1 would spread out the responsibility of the plan to multiple people, away from the factory level, whereas Solution 2 keeps the control more focused although various people are asked for their insight. At the moment the profit and loss (P&L) responsibility in the case company is still in the factory level. Going into the Solution 1 would introduce a mismatch in the company, when the factory would have the P&L responsibility, while sales offices would have the responsibility of the demand plans and their accuracy.

On the other hand, the approaches to demand planning of the benchmark companies are closer to Solution 1. This is an interesting difference between the case company and the benchmark companies. However, as was found in the literature, the appropriate S&OP and demand planning process depends on the characteristics of the company.

While at the moment the characteristics of the company might support one of the demand planning approaches more, the existing situation should not be taken as granted. The situation and its characteristics should be judged with open mind and thus find the best possible solution for the future.

8. Recommendation

For the case company I would recommend implementing Solution 2 in the current situation. As the number of the sources of demand would most probably be huge and the demand forecasting in most of these sources is not a current process, implementing the Solution 1 would require extensive time and efforts. Solution 2 is better supported by the current process and systems.

Parts of the Solution 1 can be implemented gradually after the Solution 2 has been successful for a certain time. The Solution 1 has the advantages of getting the forecasts from close to the customer, giving the best possible information about the situation in the market and the efforts done to answer that demand. But as said, as long as the demand planning close to the customer is not a set process, the inputs received could have such a low quality that the demand plan aggregated from the different inputs would lose its credibility.

As mentioned previously, in order to be able to take Solution 2 into use, the case company has to identify the indicators most relevant to its business and start gathering the information in a structured way. Possible indicators were found in Chapter 5 that correlate with the orders better than the indicators utilized at the moment. In the demand planning organization there should also be a person in charge of the indicators and the analysis of their implications to the business. In addition to the indicators of the market situation, people having other relevant information should contribute to the demand planning process. This would include all the people related to change situations, e.g. product management informing about product ramp ups and downs or key account managers informing about changes in the product mix of big customers. This is also information that should be gathered in a structured way so that the past could also be analyzed and be learned from. The gathering of additional information would also be in line with the findings from the literature, as it has been found that managers who collect more information make more effective decisions (Dean & Sharfman 1996). The weight of importance for various inputs can vary within the time horizon, as was found to be the case in a study made by Oliva and Watson (2011) and as was suggested by Capon and Palij (1994).

Thus to be able to have a demand planning process that works efficiently and results in accurate plans, there is a need for clear improvements to the current process. In addition to adding more sources of information in to the process, also clear ownership of demand planning and its inputs should be defined. The clarification of demand planning goals and advantages should improve the commitment from people taking part in the process. Each of

the demand plan inputs should have a person responsible for the information, including storing the information and analyzing the past to make sure that the accuracy of the plans will improve.

The suggestion of the demand planning organization to support this process can be seen in Table 13.

TABLE 13 SUGGESTED DEMAND PLANNING ORGANIZATION

	Goal	People in the meeting	Person in charge
Before demand review meeting	Gathering information about the demand from various sources • Market intelligence • Sales regions • Sales offices • Projects • KAMs • PM	No meeting, information combined into a one page summary per responsible person → Distributed before the demand review meeting (templates provided)	**Each input has a person responsible** for gathering, storing and analyzing the data
Demand review meeting	Combining the information from various sources into a consensus demand plan Clear agenda for the meeting	• Sales responsible • Area/Region manager – representative • KAM-representative • PM-representative • S&OP coordinator • **Demand planner/ business analyst** (responsible also for market intelligence and statistical forecasting)	**Sales responsible**
PreS&OP		• Same as current PreS&OP, Sales responsible owns demand plan	**Financial/ business controller**

The relevant information should be gathered before the meetings and also distributed before the meetings so that people can be prepared when coming to the demand planning meeting. This would fit the findings of Weigand (2013), who suggested that people have a limited capability of expressing knowledge, which can be compensated by collaborative methods and structured dialogical approaches. As the S&OP process has been quite Operations-led in the case company, it is suggested to have a more neutral person in charge in the PreS&OP meeting to help form a consensus plan with all the stakeholders in the S&OP process.

However, the demand plan should be owned by Sales. This neutral manager of S&OP (Financial/Business Controller) should be the facilitator between the (possible) conflicts of interest between Sales and Operations.

A demand planner/business analyst, who possesses deep knowledge of both the business and the S&OP process is essential for the process. This person can facilitate the interactions between the different functions and also has a holistic view of the big picture. The demand planner/business analyst would be specifically in charge of the market intelligence and statistical forecast, but also of the implementation of all information sources into the demand plan.

As the demand planning process is being improved, the **flow of information to top management decision making** should also be improved. Templates for communicating the relevant information were developed during the course of this thesis. Their use should be continued and the process should be continuously iterated to be improved.

Thus in the context of the case company, the answers to the research question present in the beginning of this thesis come down to **clear ownership, better communication** and **more fact-based decisions.** In order to have an efficient and effective demand planning process, more relevant information is needed. This information should be stored and analyzed to be able to create a fact-based demand plan. In order to have good quality information, the commitment of people and the clear ownership of the information sources needs to be developed. Once the input information is of good quality and the demand planning process supports the information sharing, storing and analyzing, the accuracy of the demand plans should improve.

9. Conclusion

9.1. Conclusion of the study

The findings of this thesis include the possible sources of information for demand planning as well as information about how to organize the process itself. As can be seen especially from the benchmark interviews and the analysis of the case company, there is no general solution for a demand planning process. Instead what should be done is to identify the best possible sources for information in each separate case, and then focus on developing a process that efficiently uses this information. The information flow and the involvement and commitment of people are some of the main challenges that were found to have a large impact on the success of the process. S&OP was also found to be more relevant to strategic planning nowadays than its original role as purely balancing demand and supply.

As a result of this thesis, an improved demand planning process was developed for the case company. From the two possible solutions developed, the Solution 2 was found more suitable and was chosen. The main difference of the two approaches is the division of responsibility. Both of the solutions bare the same core idea: combining information from multiple sources, focusing on getting close to the end demand, and developing a good fact-based demand plan based on the multiple sources of information.

9.2. Evaluation of the study

9.2.1. Limitations

The limitations of this study include the lack of research on the demand planning processes of the sales offices. Even though this was out of the scope of this thesis, the knowledge of what information is available and where, would have been helpful for this thesis. This research should be done to be able to implement the proposed solution well, and also to identify the most relevant sources of information for the company.

To get on even more comprehensive view of the demand planning process of the company, even more people could have been interviewed. This would have provided an even more holistic view of the state of the current demand planning process. It might have also helped in identifying more small ideas within the company about the possible improvements made to the demand planning process.

9.3. Future research topics

In the literature review made for the thesis it was found that the improvements of the demand planning process can be **hard to quantify**. These aspects should be researched further (both in academia and in the case company), since the ability to quantify the results would help in explaining the value of the whole demand planning process to the people involved. It might also help the top management in providing financial incentives to the parties involved as they would have the knowledge of how much they are saving money by increasing their accuracy by for example 5%.

Another future research topic for the case company would be to investigate the forecasting and **planning processes in various sales offices**. The closer the company would get to the customers, the more relevant information the case company would acquire for its demand planning processes. In general the planning process of multiple levels should be investigated further in the academia as well. How to plan, when there is a whole chain from the customer to the sales office to the regional managers to the factory planners within one company?

In academia it would be interesting to research the complex planning processes of a multinational company. At the moment many of the researches have been simplified into models that include one product, few customers and few factories. But the process of multiple products, customers and factories affecting each other should be investigated further.

In general the topics related S&OP are various, and in addition to those mentioned, for example the combination of statistical forecasting and judgmental adjustments should be investigated further, as well as the process of making a plan with multiple people involved, all of whom would like to make their changes to the plans in different levels.

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Appendices

Appendix 1 – Conducted interviews

Date	PG1/PG2/Benchmark	Role
25.3.2014	PG1	Operations
28.3.2014	PG1	Sales
10.4.2014	PG1	Operations
10.4.2014	PG1	Sales
16.4.2014	PG1 & PG2	Other
16.4.2014	Benchmark	Benchmark
17.4.2014	Benchmark	Benchmark
25.4.2014	PG1	Product Management
29.4.2014	PG2	Sales
7.5.2014	PG1	Sales
7.5.2014	PG2	Other
8.5.2014	Benchmark	Benchmark
12.5.2014	PG2	Sales
13.5.2014	PG1 & PG2	Sales
13.5.2014	PG1 & PG2	Sales
14.5.2014	Benchmark	Benchmark
21.5.2014	Benchmark	Benchmark
22.5.2014	PG2	Product Management
23.5.2014	PG1 & PG2	Product Management
27.5.2014	PG2	Sales
30.5.2014	PG1 & PG2	Market intelligence

Appendix 2 – Numerical representation of the Holt-Winters' forecasting method

					beta:	gamma:			
					0,9	0,9			
Period	Month	OI	Statistical forecast	Level	Trend	Seasonal adjustment	Alpha	WMAPE	Error
0	2011-01	100 000	100 000	100 000	10 000	1,00	0,40	0,00	0,00
1	2011-02	110 000	110 000	110 000	10 000	1,00	0,96	0,00	0,00
2	2011-03	99 000	120 000	120 000	10 000	1,00	0,00	0,07	21 000,00
3	2011-04	108 900	130 000	125 524	5 972	1,00	0,21	0,10	21 099,60
4	2011-05	98 010	131 496	125 008	133	1,00	0,19	0,15	33 485,63
5	2011-06	107 811	125 140	119 220	-5 196	1,00	0,34	0,15	17 329,31
6	2011-07	97 030	114 024	111 292	-7 654	1,00	0,16	0,15	16 993,76
7	2011-08	106 733	103 638	104 180	-7 167	1,00	0,18	0,13	-3 095,16
8	2011-09	96 060	97 013	96 986	-7 191	1,00	0,03	0,12	953,71
9	2011-10	105 666	89 794	89 952	-7 050	1,00	0,01	0,09	-15 871,31
10	2011-11	95 099	82 902	84 734	-5 401	1,00	0,15	0,07	-12 196,76
11	2011-12	104 609	79 333	82 575	-2 483	1,00	0,13	0,04	-25 275,46
12	2012-01	94 148	89 296	83 488	573	1,11	0,24	0,04	-4 852,51
13	2012-02	103 563	100 511	85 067	1 478	1,20	0,05	0,03	-3 051,45
14	2012-03	93 207	92 350	86 741	1 655	1,07	0,03	0,03	-856,05
15	2012-04	102 527	100 979	88 525	1 771	1,14	0,01	0,03	-1 548,47
16	2012-05	92 274	92 049	90 326	1 798	1,02	0,02	0,03	-225,26
17	2012-06	101 502	100 542	92 148	1 819	1,09	0,00	0,02	-960,41
18	2012-07	91 352	91 635	93 942	1 797	0,98	0,01	0,02	283,13
19	2012-08	100 487	99 998	95 753	1 810	1,04	0,00	0,02	-488,75
20	2012-09	90 438	91 180	97 528	1 779	0,93	0,00	0,02	741,40
21	2012-10	99 482	99 463	99 309	1 780	1,00	0,01	0,02	-18,79
22	2012-11	89 534	90 691	101 086	1 778	0,90	0,00	0,02	1 157,21
23	2012-12	98 487	98 974	102 808	1 727	0,96	0,01	0,02	486,49
24	2013-01	88 638	91 524	104 411	1 616	0,88	0,00	0,02	2 885,37
25	2013-02	97 502	101 094	105 230	899	0,95	0,03	0,02	3 591,90
26	2013-03	87 752	90 962	105 248	106	0,86	0,04	0,02	3 210,15
27	2013-04	96 527	99 544	104 592	-580	0,94	0,04	0,02	3 016,23
28	2013-05	86 875	89 234	103 424	-1 109	0,86	0,03	0,02	2 359,48
29	2013-06	95 562	97 510	101 915	-1 469	0,95	0,03	0,02	1 948,30
30	2013-07	86 006	87 394	100 196	-1 694	0,87	0,02	0,02	1 387,69
31	2013-08	94 606	102 884	98 374	-1 809	1,04	0,02	0,02	8 277,87
32	2013-09	85 146	90 246	96 476	-1 889	0,93	0,02	0,02	5 100,63
33	2013-10	93 660	94 737	94 571	-1 904	1,00	0,02	0,02	1 076,31
34	2013-11	84 294	83 135	92 687	-1 885	0,90	0,02	0,02	-1 159,07
35	2013-12	92 724	87 368	90 892	-1 805	0,96	0,02	0,02	-5 356,21
36	2014-01		78 825	0	0	0,88	0,02		
37	2014-02		84 227	0	0	0,95	0,02		
38	2014-03		74 261	0	0	0,86	0,02		
39	2014-04		80 263	0	0	0,94	0,02		
40	2014-05		71 426	0	0	0,86	0,02		
41	2014-06		77 729	0	0	0,95	0,02		
42	2014-07		69 488	0	0	0,87	0,02		
43	2014-08		81 650	0	0	1,04	0,02		
44	2014-09		71 474	0	0	0,93	0,02		
45	2014-10		74 901	0	0	1,00	0,02		
46	2014-11		65 571	0	0	0,90	0,02		
47	2014-12		68 694	0	0	0,96	0,02		
						sum of WMAPE		1,62	

Appendix 3 – OECD Chosen areas and their definitions

US	United States
Euro area	Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Slovak Republic, Slovenia, Spain
4 Big European Countries	France, Germany, Italy, United Kingdom
G7	Canada, France, Germany, Italy, Japan, United Kingdom, United States
NAFTA	North American Free Trade Agreement: Canada, Mexico and United States
OECD – Europe	Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Slovak Republic, Slovenia, Spain
OECD – Total	Comprises of the 34 OECD countries except Ireland
OECD + Major six NME	NME = Non-member economies This covers all the OECD countries + Brazil, China, India, Indonesia, Russian Federation and South Africa
Major Five Asian Countries	China, India, Indonesia, Japan, Korea
China	China

OECD countries include Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States

Appendix 4 – Examples of correlation tables

OECD – Region ”All” – Product line ”All”

Regi	Product line	P(	Area/Lag	0	1	2	3	4	5	6	7	8	9	10	11	12
All	All	PG1	United States	low	mid	low	low	low	low	low	high	mid	mid	low	low	low
All	All	PG2	United States	low	high	mid	mid	low	low	low	mid	mid	mid	high	mid	mid
All	All	PG1	Euro18	low	low	low	mid	low		low	high	mid	mid	low	low	low
All	All	PG2	Euro18	low	high	mid	low	low		low	mid	mid	mid	high	mid	mid
All	All	PG1	4BEuropean	low	mid	low	low	low	mid	high	mid	mid	low	low	low	low
All	All	PG2	4BEuropean	low	high	mid	mid	low	mid	mid	mid	mid	high	mid	mid	mid
All	All	PG1	G7	mid	mid	low	low	low	low	high	mid	mid	low	low	low	low
All	All	PG2	G7	low	mid	low	mid	low	low	mid	mid	mid	high	mid	mid	mid
All	All	PG1	NAFTA	mid	mid	low	low	low	low	high	mid	mid	low	low	low	low
All	All	PG2	NAFTA	mid	mid	mid	mid	low	low	mid	mid	mid	high	mid	mid	mid
All	All	PG1	OECD-Europe	mid	low	low	low	low	mid	high	mid	mid	low	low	low	low
All	All	PG2	OECD-Europe	mid	low	mid	low	low	low	mid	mid	mid	high	mid	mid	mid
All	All	PG1	OECD-Total	mid	low	low	low	low	mid	high	mid	mid	low	low	low	low
All	All	PG2	OECD-Total	mid	mid	mid	mid	low	mid	mid	mid	mid	high	mid	mid	mid
All	All	PG1	OECDPlusMajor6NME	low	low	mid	low		low	high	mid	mid	low	low	low	low
All	All	PG2	OECDPlusMajor6NME	mid	mid	low	high		low	mid	mid	mid	high	mid	mid	mid
All	All	PG1	Major5Asia	mid	low	low	low	low	mid	high	mid	mid	low	low	low	low
All	All	PG2	Major5Asia	mid	mid	mid	mid	low	low	mid	mid	mid	high	mid	mid	mid
All	All	PG1	China	mid	low	low	low	low	low	high	mid	mid	low	low	low	low
All	All	PG2	China	mid	low	mid	low	low	low	mid	mid	mid	high	mid	mid	mid

OECD – Region “All” – Product line “Product line 1”

Regi	Product line	P(	Area/Lag	0	1	2	3	4	5	6	7	8	9	10	11	12
All	Product line 1	PG1	United States	low	mid	mid	mid	mid	mid	low	high	high	mid	mid	high	mid
All	Product line 1	PG2	United States	low	high	high	mid	mid	mid	low	mid	mid	high	high	high	mid
All	Product line 1	PG1	Euro18	low	mid	mid	mid	high		low	high	high	mid	mid	high	mid
All	Product line 1	PG2	Euro18	low	high	mid	low	high		low	mid	mid	high	high	high	mid
All	Product line 1	PG1	4BEuropean	low	mid	high	mid	high	mid	high	high	mid	high	high	mid	mid
All	Product line 1	PG2	4BEuropean	low	high	high	mid	mid	mid	mid	mid	high	high	high	high	mid
All	Product line 1	PG1	G7	mid	mid	high	mid	low	low	high	high	mid	mid	high	mid	mid
All	Product line 1	PG2	G7	low	mid	high	mid	low	low	mid	mid	high	high	high	high	mid
All	Product line 1	PG1	NAFTA	high	mid	mid	mid	mid	low	high	high	mid	mid	high	mid	mid
All	Product line 1	PG2	NAFTA	low	high	high	mid	mid	low	mid	mid	high	high	high	high	mid
All	Product line 1	PG1	OECD-Europe	mid	mid	mid	mid	mid	mid	high	high	mid	high	high	mid	mid
All	Product line 1	PG2	OECD-Europe	low	high	mid	low	mid	low	mid	mid	high	high	high	high	mid
All	Product line 1	PG1	OECD-Total	mid	mid	high	mid	high	mid	high	high	mid	high	high	mid	mid
All	Product line 1	PG2	OECD-Total	low	high	mid	mid	mid	low	mid	mid	high	high	high	high	mid
All	Product line 1	PG1	OECDPlusMajor6NME	mid	mid	high	high		low	high	high	mid	mid	high	mid	mid
All	Product line 1	PG2	OECDPlusMajor6NME	high	mid	low	high		low	mid	mid	high	high	high	high	mid
All	Product line 1	PG1	Major5Asia	mid	mid	high	mid	mid	low	high	high	mid	mid	high	mid	mid
All	Product line 1	PG2	Major5Asia	mid	high	mid	mid	mid	low	mid	mid	high	high	high	high	mid
All	Product line 1	PG1	China	mid	mid	mid	low	mid	low	high	high	mid	mid	high	mid	mid
All	Product line 1	PG2	China	mid	high	mid	low	mid	low	mid	mid	high	high	high	high	mid

Brent – Region “All” + “Area 1”+ “Area 2”

Region Nam	Product line	PG	0	1	2	3	4	5	6	7	8	9	10	11	12
All	All	PG1	low	low	low	low	mid	mid	mid	low	high	high	high	low	mid
All	Product line 1	PG1	low	low	low	mid	mid	mid	mid	high	high	mid	high	high	high
All	Product line 2	PG1													
All	Product line 3	PG1	low	low	low	low	mid	mid	mid	low	mid	mid	high	low	mid
All	Product line 4	PG1	low	low	low	low	mid	mid	mid	low	mid	mid	high	low	mid
All	Other	PG1	low	low	low	mid	low	low	low	mid	low	low	low	mid	mid
Area 1	All	PG1	low	low	low	mid	mid	mid	mid	mid	mid	mid	mid	mid	high
Area 1	Product line 1	PG1	low	low	low	high	low	low	low	high	mid	mid	mid	high	high
Area 1	Product line 2	PG1													
Area 1	Product line 3	PG1	low	low	low	low	mid	mid	mid	low	mid	mid	mid	low	mid
Area 1	Product line 4	PG1	low	low	low	low	low	mid	low	low	mid	mid	mid	low	mid
Area 1	Other	PG1	low	low	low	mid	mid	mid	mid	mid	mid	mid	mid	mid	high
Area 2	All	PG1	low	low	low	low	low	low	low	low	low	low	low	low	low
Area 2	Product line 1	PG1	low	low	low	mid	mid	mid	mid	mid	high	mid	high	mid	mid
Area 2	Product line 2	PG1													
Area 2	Product line 3	PG1	low	low	mid	low	low	low	low	low	low	low	low	low	low
Area 2	Product line 4	PG1	low	low	low	low	mid	low	mid	low	low	low	low	low	low
Area 2	Other	PG1	mid	mid	mid	low	low	low	low	low	low	low	low	low	low
All	All	PG2	low	low	low	mid	mid	mid	mid	mid	mid	mid	mid	mid	mid
Area 1	All	PG2	low	low	low	low	mid	mid	mid	low	mid	mid	mid	low	mid
Area 2	All	PG2	low	low	low	low	low	low	low	low	low	mid	mid	low	low
All	Product line 1	PG2	low	low	low	high	low	low	low	high	mid	mid	mid	mid	mid
All	Product line 2	PG2	low	low	low	mid	mid	mid	mid	low	mid	mid	mid	low	high
All	Product line 3	PG2	mid	mid	low	low	mid	mid	mid	low	low	low	low	low	low
All	Other	PG2	mid	mid	low	low	low	low	low	low	low	low	low	low	low
Area 1	Product line 1	PG2	low	low	low	low	low	low	low	low	low	low	low	low	mid
Area 1	Product line 2	PG2	low	low	low	low	mid	mid	mid	low	mid	mid	mid	low	low
Area 1	Product line 3	PG2	low	low	low	low	low	low	low	low	low	low	low	low	mid
Area 1	Other	PG2	low	low	low	low	low	low	low	low	low	low	low	low	mid
Area 2	Product line 1	PG2	low	mid	low	low	low	low	low	low	low	low	low	low	low
Area 2	Product line 2	PG2	low	low	low	low	mid	mid	mid	low	low	low	low	low	low
Area 2	Product line 3	PG2	low	low	low	low	low	low	low	low	low	low	low	low	low
Area 2	Other	PG2													

PMI – Region “All”

Region	Product line	PG	Area	0	1	2	3	4	5	6	7	8	9	10	11	12
All	All	PG1	US	low	mid	high	mid	low	low	low	low	low	low	low	low	low
All	Product line 1	PG1	US	low	mid	high	high	mid	mid	mid	mid	high	high	mid	mid	mid
All	Product line 2	PG1	US													
All	Product line 3	PG1	US	low	mid	mid	mid	low	low	low	low	low	low	low	low	low
All	Product line 4	PG1	US	low	mid	mid	mid	low	low	low	low	low	low	low	low	low
All	Other	PG1	US	low	low	low	mid	mid	mid	mid	mid	mid	mid	high	high	high
All	All	PG2	US	low	mid	mid	mid	mid	high	mid	mid	mid	mid	low	low	low
All	Product line 1	PG2	US	low	low	mid	mid	high	high	high	high	high	mid	mid	mid	mid
All	Product line 2	PG2	US	low	mid	mid	high	high	high	mid	mid	low	low	low	low	low
All	Product line 3	PG2	US	mid	mid	low	low	low	low	low	low	low	low	low	low	low
All	Other	PG2	US	mid	low	low	low	low	low	low	low	low	low	low	low	low
All	All	PG1	EUR	low	mid	high	mid	low	low	low	low	low	low	low	low	low
All	Product line 1	PG1	EUR	low	mid	mid	mid	mid	mid	mid	mid	high	high	mid	mid	mid
All	Product line 2	PG1	EUR													
All	Product line 3	PG1	EUR	low	mid	mid	mid	low	low	low	low	low	low	low	low	low
All	Product line 4	PG1	EUR	low	mid	mid	mid	low	low	low	low	low	low	low	low	low
All	Other	PG1	EUR	low	low	low	low	low	low	mid	mid	mid	mid	high	high	high
All	All	PG2	EUR	low	mid	mid	mid	mid	high	mid	mid	mid	mid	low	low	low
All	Product line 1	PG2	EUR	low	low	mid	mid	high	high	high	high	high	mid	mid	mid	mid
All	Product line 2	PG2	EUR	low	mid	mid	high	high	high	mid	mid	low	low	low	low	low
All	Product line 3	PG2	EUR	mid	mid	low	low	low	low	low	low	low	low	low	low	low
All	Other	PG2	EUR	mid	low	low	low	low	low	low	low	low	low	low	low	low
All	All	PG1	CN	low	mid	high	mid	low	low	low	low	low	low	low	low	low
All	Product line 1	PG1	CN	low	mid	high	high	mid	mid	mid	mid	mid	high	mid	mid	mid
All	Product line 2	PG1	CN													
All	Product line 3	PG1	CN	low	mid	high	mid	low	low	low	low	low	low	low	low	low
All	Product line 4	PG1	CN	low	mid	high	mid	low	low	low	low	low	low	low	low	low
All	Other	PG1	CN	low	low	low	mid	mid	mid	mid	mid	mid	mid	high	high	high
All	All	PG2	CN	low	mid	mid	mid	mid	high	mid	mid	mid	mid	low	low	low
All	Product line 1	PG2	CN	low	low	mid	mid	mid	high	high	high	high	mid	mid	mid	mid
All	Product line 2	PG2	CN	low	mid	mid	high	mid	high	mid	mid	low	low	low	low	low
All	Product line 3	PG2	CN	low	mid	low	low	low	low	low	low	low	low	low	low	low
All	Other	PG2	CN	low	low	low	low	low	low	low	low	low	low	low	low	low
All	All	PG1	Global	low	low	low	low	low	low	mid	mid	low	low	low		
All	Product line 1	PG1	Global	mid	high	high	mid	mid	mid	mid	mid	mid	low	low		
All	Product line 2	PG1	Global													
All	Product line 3	PG1	Global	low	low	low	low	low	low	low	low	low	low	low		
All	Product line 4	PG1	Global	low	low	low	low	low	low	low	mid	low	low	low		
All	Other	PG1	Global	mid	mid	mid	high	high	high	high	high	high	mid	mid		
All	All	PG2	Global	mid	mid	mid	low	low	low	low	low	low	low	low		
All	Product line 1	PG2	Global	high	high	mid	mid	mid	mid	low	low	low	low	low		
All	Product line 2	PG2	Global	mid	low	low	low	low	low	low	low	low	low	low		
All	Product line 3	PG2	Global	low	low	low	low	low	low	low	low	low	low	low		
All	Other	PG2	Global	low	low	low	low	low	low	low	low	low	low	low		